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No. 38

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USSR AND EASTERN EUROPE SCIENTIFIC ABSTRACTS

PHYSICS AND MATHEMATICS

No. 38

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USSR

ON THE THEORY OF ACOUSTIC MODULATION OF GAMMA RADIATION

Leningrad FIZIKA TVERDOGO TELA in Russian Vol 19 No 6, Jun 77 pp 1650-1652
manuscript received 16 Dec 76

SADYKOV, E. K., Kazan' State University imeni V. I. Ul'yanov-Lenin

[Abstract] The phenomenon of acoustic modulation of γ -radiation has been thoroughly investigated theoretically, and is now being put to extensive use in physical research. Experimental observations of the effect have been made on the basis of sound excitation by piezoelectricity and magnetostriction. The experiments have confirmed the theoretical conclusions: satellites show up in the gamma resonance spectrum that are separated from the fundamental line by $\pm n\omega_s$ ($n = 1, 2, 3, \dots$) where ω_s is the frequency of the stimulated sound. Intensities of ultrasonic satellites have been calculated with the assumption that the sound is coherent, and with the assumption that the distribution of acoustic phonons is described by thermal distribution with a certain effective temperature. In this paper the author proposes a method of calculating the intensities of ultrasonic satellites of Mössbauer emission based on the density matrix of the acoustic mode, assuming coherent states. In particular, an examination is made of the case where the acoustic mode can be represented as a superposition of "thermal" and coherent phonon fields. The expression derived on this basis for the intensity of satellites agrees qualitatively with experimental results. In conclusion the author thanks Sh. Sh. Bashkirov for discussion of the problem. References 10: 3 Russian, 7 Western.

USSR

STRONGLY INTERACTING BOUND STATES IN CHANNELING OF FAST ELECTRONS

Leningrad FIZIKA TVERDOGO TELA in Russian Vol 19 No 7, Jul 77 pp 1958-1965
manuscript received 27 Dec 76

KAPLIN, V. V., and VOROB'YEV, S. A., Institute of Nuclear Physics at Tomsk
Polytechnical Institute imeni S. M. Kirov

[Abstract] This paper gives a demonstration for the first time of the role of bound states interacting strongly with the atoms of a crystal in formation of relationships between orientation and Rutherford scattering and angular distributions of electron transmission and emission. Based on a model of "de-channeling" of electrons from states, an analysis is also made of the contribution of individual states to formation of a stream of channeling electrons (electrons which penetrate anomalously deeply into a single crystal) in a crystal and of angular distributions for crystals of different thicknesses. Calculations are based on the quantum mechanics theory of bound motion of fast electrons relative to the atomic axes of single crystals of silicon and gold. A criterion is first derived for distinguishing between strongly interacting and deeply penetrating states. Curves are given showing the relationship between the distribution density of fast electrons with energy of 1.0 MeV passing through a single crystal of Si with orientation $\langle 111 \rangle$ and bound states of types 1s, 2s, and 2p. For comparison the distribution densities of electrons are shown for chaotic passage in the crystal. The states of channeled electrons can be divided into strongly interacting and deeply penetrating without close interaction with atoms. A study is made of the relationship between the orientation of the crystal and close interactions of channeled electrons, in terms of probability of the latter. For this a discussion is given of the evolution of particle capture into each of the strongly interacting states with a specific angle at which electrons strike the crystal with a given orientation. Curves are shown for the probability densities for formation of bound states as a function of the angle of incidence of electrons on a silicon crystal with orientation $\langle 111 \rangle$. A comparison is made between experimental and calculated curves showing the relationship between orientation and Rutherford scattering of electrons in a silicon single crystal. A comparison of similar curves is made for thin crystals of Au for electrons of differing energy. Good agreement is found. A study is made of angular distributions of electrons passing through a single crystal in strongly interacting states. These distributions are compared for different states. A study is also made of the relationship between passage of channeled electrons and the thickness of the single crystal. Electron-diffraction patterns are shown for Si crystals of different thicknesses. As the thickness of the crystal increases a greater number of particles in strongly interacting states, under the influence of the perturbation caused by discreteness of the atomic chain, make a transition to high-lying bound levels, even in the continuous-spectrum energy region state. The test of acceptance for strongly interacting electrons in channeling introduced in this paper makes it possible to analyze the dependence of Rutherford scattering on both orientation and energy. The effect of intensifying close interactions between electrons and atoms in channeling can be utilized for radiative disordering of surface layers of single crystals and

for selective intensification of the result of elastic processes in layers near the surface or in epitaxial films. Figures 4; references 18: 6 Russian, 12 Western.

USSR

GENERATION OF PLASMONS DURING ION BOMBARDMENT AND ASSOCIATED EFFECTS

Leningrad FIZIKA TVERDOGO TELA in Russian Vol 19 No 7, Jul 77 pp 1920-1926
manuscript received 18 Oct 76

FILIPPOV, G. M., Chuvash State University imeni I. N. Ul'yanov, Cheboksary

[Abstract] Plasma oscillations can occur when metals are bombarded with beams of energetic charged particles. The energy of these oscillations varies discretely; plasma oscillation quanta--plasmons--originate and are destroyed. In order for a plasmon to be emitted the velocity of the particle has to be sufficiently high. Plasmons which originate in the generation process have a finite lifetime. Some of the processes responsible for this fact are discussed in this paper. Two factors are at work with a steady stream of charged particles: generation and destruction of plasmons. This paper is concerned with calculating the kinetics of a system of plasmons, taking both factors into account, as well as with analyzing the influence of this system on the properties of the metal. A theoretical analysis is made of the process of disintegration of a plasmon into two electron-hole pairs, beginning with a specific type of Hamiltonian for electron-plasmon and electron-pair interaction. A formula is derived for the probability of disintegration of a plasmon into two pairs over a unit of time. Diagrams are shown which describe the emission of plasmons when the metal is irradiated in lower orders, in terms of the external particle. A formula is given for finding the number of plasmons emitted per unit of time by each particle. Plasmons with low momenta can originate owing to emission of a plasmon and a pair via a virtual electron and to successive emission of a plasmon and a pair, as well as owing to dissipation of a plasmon with emission of a pair. An evaluation is made of the contribution of these processes to generation of longlife plasmons. A discussion is given of the kinetics of the process of generation of plasmons during ion bombardment for a short period. An examination is made of the problem of whether buildup of slightly damped plasmons with low momentum is possible with a steady stream of external particles. It is shown that in reality accumulation plasmons is possible in states with low momenta, the number increasing exponentially. A calculation is made of the total amount of electrical energy stored in the metal under the effect of the total exposure dose. For this a calculation is made of energy losses on the part of the external particle associated with emission of plasmons and pairs. Curves are given which show respective plasmon and hole losses for aluminum. The density of electrical energy is expressed in terms of electrical pressure. Estimates made for aluminum show that this pressure can reach approximately 10^6 atm with doses of approximately 0.01 standard units. Figures 4; references 7: 4 Russian, 3 Western.

USSR

JUMP CONDUCTIVITY OF UNORDERED SEMICONDUCTORS IN A STRONG FIELD

Moscow PIS'MA V ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian
Vol 25 No 8, 20 Apr 77 pp 345-347 manuscript received 9 Nov 76 and after revision 17 Feb 77

KOSTADINOV, I. Z., Sofia University, Physics Faculty, Department of Theoretical Physics

[Abstract] The jump conductivity of unordered semiconductors in a strong field is computed. It is shown that after an exponential growth in conductivity with the field there is a linear segment due to the jumps between nearest neighbors with and without phonon emission. The results of the high-frequency measurements of absorption in InSb demonstrate a power-law dependence of damping on phonon energy with an exponent near five. It was found that the growth in conductivity is slowed down although there are no detailed measurements in the area of strong fields. The F_0 fields have relatively small values for narrowband materials. References 6: 5 Russian, 1 Western.

USSR

UDC 535

COHERENT PROPERTIES OF AN INTERACTING ELECTROMAGNETIC FIELD

Minsk IZVESTIYA AKADEMII NAUK BSSR, SERIYA FIZIKO-MATEMATICHESKIKH NAUK in Russian No 2, 1977 pp 62-65 manuscript received 28 Apr 75

STOLYAROV, A. D., Institute of Physics, Academy of Sciences BSSR

[Abstract] This work is dedicated to determination of the normalized correlation functions of a single-mode electromagnetic field interacting with a phonon field in the presence of an external signal given as function of time. The statistical properties of the electromagnetic field are analyzed. Normalized correlation functions of arbitrary order are constructed as functions of time and of the initial state of the field. It is shown that in the steady state, the field is characterized only by the parameters of the mechanism of attenuation and the external source of signals. References 5: 4 Russian, 1 Western.

USSR

UDC 534.222.2;518:517

CALCULATING THE EXCITATION OF A DETONATION BY SHOCK WAVES

Novosibirsk FIZIKA GORENIYA I VZRYVA in Russian Vol 13 No 3, May/Jun 77 pp 416-420 manuscript received 9 Feb 76

BATALOVA, M. V., BAKHRAKH, S. M., and ZUBAREV, V. N.

[Abstract] Gasdynamic calculations are done on initiation of nitromethane by shock waves of different amplitudes. Equations of state were used that agree with shock-wave experiments and with the detonation characteristics of nitromethane. The kinetics of the process were described by the Arrhenius equation. The analysis covered changes in pressure, mass velocities and the pressure of wave fronts in the process of stimulation and formation of the detonation wave in nitromethane. Figures 4; tables 2; references 11: 9 Russian, 2 Western.

USSR

UDC 662.215.4

INFLUENCE THAT THE CONDITIONS OF INITIATION OF A DETONATION IN A CHARGE HAVE ON ITS AFTEREFFECT

Novosibirsk FIZIKA GORENIYA I VZRYVA in Russian Vol 13 No 2, Mar/Apr 77 pp 291-293 manuscript received 3 Feb 76

KUZNETSOV, O. A., SOLOV'YEV, V. S., BOYKO, M. M., VLASOVA, L. N., and POSTNOV, V. N., Moscow Higher Technical Academy imeni N. E. Bauman

[Abstract] The initiation of detonation in an explosive is accompanied by a transition zone where the parameters in the initiating shock wave front change from the initial to detonating parameters. The authors estimate the influence that the size of this zone and hence the initiation conditions have on the nature of the aftereffect of the explosive charge. The aftereffect was evaluated from the expansion curve in coordinates of pressure vs. mass velocity. These curves were plotted for TNT charges with density of 1.51 and 1.60 g/cc. The lengths of the charges varied from 5 to 20 mm. Detonation was initiated by a plane shock wave with amplitude of 55 and 70 kbar and duration of more than 1 μ s. An explosive charge that has a large zone of transition from the initiating shock wave to the detonation wave gives a flatter expansion curve. For a specific explosive charge there exist optimum conditions of initiation that maximize the propulsive effect. Figures 4; references 5 (Russian).

USSR

UDC 533.9:535.21

CALCULATION OF TRANSIENT AXISYMMETRIC PLASMA FLARES DUE TO OPTICAL DETONATION

Minsk DOKLADY AKADEMII NAUK BSSR in Russian Vol 21 No 6, Jun 77 pp 503-506
manuscript received 23 Aug 76

ROMANOV, G. S., and STANKEVICH, YU. A., Scientific Research Institute of Applied Problems in Physics, Belorussian State University imeni V. I. Lenin

[Abstract] The dynamic behavior of a plasma flare forming due to irradiation of a target, an absorbent barrier, by a cylindrical light beam is analyzed here on the basis of gas dynamic theory. The flare generated by evaporation of the target material at the surface moves counter to the incident light and, depending on the conditions, either completely or partially absorbs the latter, while it loses energy through de-excitation by the bremsstrahlung and photoelectric mechanisms. The fundamental equations of gas dynamics are set up in the one-dimensional approximation, in cylindrical coordinates and in Euler variables, supplemented with the equation of state for the plasma. A numerical solution to this closed system of equations is found by the method of "large particles" extended to the case of nonadiabatic flow, with appropriate boundary conditions. The results indicate that it is feasible to numerically simulate processes which occur in real two-dimensional optical-erosive flares intensively interacting with radiation. Figures 2; references 12: 11 Russian, 1 Western.

USSR

UDC 533.09.95

EFFECT OF THE VELOCITY OF ELECTRODE FLARES ON THE HYDRODYNAMIC INSTABILITY OF THE LINEAR Z-PINCH

Dushanbe DOKLADY AKADEMII NAUK TADZHIKSKOY SSR in Russian Vol 20 No 2, 1977 pp 26-29 manuscript received 8 Jun 76

SULTANOV, M. A., Institute of Chemistry, Academy of Sciences of the Tadzhik SSR

[Abstract] Supersonic electrode flares cause not only conventional hydrodynamic instabilities of a plasma discharge column but also instabilities associated with a shock wave and its radial propagation through the discharge gap, at supersonic velocity, resulting in accelerated dissipation of the plasma discharge column as well as of the shock-compressed plasma region. This so-called gyrotropic instability is also hydrodynamic in nature, and has been demonstrated experimentally with short high-power pulse discharges, 3 and 5 kV across a capacitance equal to 400-1200 μ F. Two open electrodes were used 10 mm apart in air under atmospheric pressure and without a magnetic field. It seems possible to somewhat stabilize the plasma discharge column, at least for extended periods of time, by varying the polarity and the atomic weight of the electrode materials. An aluminum cathode and a copper anode were found to yield the best results. Figure 1; references 14 (Russian).

USSR

UDC 621.373:535

A FABRY-PEROT LASER SPECTROMETER

Moscow OPTIKA I SPEKTROSKOPIYA in Russian Vol 43 No 2, Aug 77 pp 331-338
manuscript received 23 Jun 76

ATUTOV, S. N., KOCHANOV, V. P., SAPRYKIN, E. G., and SMIRNOV, G. I.

[Abstract] Laser spectrometry with a conventional Fabry-Perot interferometer yields the necessary resolution but is not reliable when compared with the results of measurements by other methods. Therefore, a special Fabry-Perot interferometer has been built which takes into account the peculiarities of such an application. The structure and the performance of this instrument are described here, with special emphasis on all features reducing the error of line width measurements and adjustment by a pumping laser. These features have been incorporated in the mirrors, the lenses, and the diaphragms designed and laid out so as to eliminate the frequency dispersion of reflection coefficients, chromatic aberration, transverse scattering, and the wedge effect. The instrument performance has been proved out in measurements of spontaneous radiation on a laser transition, quantitatively confirming the theory of non-linear resonances. Contemplated further improvements include automation of spectrum recording and decoding as well as the use of a spherical interferometer with higher luminosity. Figure 1; references 16: 10 Russian, 6 Western.

USSR

UDC 621.375.9:535

AMPLIFICATION AND STIMULATED EMISSION OF LIGHT IN A QUARTZ FIBER

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 4 No 4, Apr 77 pp 922-923 manuscript received 23 Feb 76, after correction 12 Oct 76

GOROVAYA, B. S., DEMSKAYA, E. L., IZOTOV, A. N., KONAREV, V. P., KONDRAT'YEV, YU. N., MATVEYEV, I. N., PROKHOROVA, T. I., TABRIN, V. N., and SHEVELEVICH, R. S.

[Abstract] In this paper a study is made of amplification and stimulated emission of radiation with wavelength of 1.06 microns in quartz fibers with the difference between the refractive indices of the core and the coating equal to about 0.005 for a wavelength of about 1.00 micron. The fibers measure 2500 mm long, with a core diameter of 16.0 microns and a concentration of activator in the core of 0.25 molar percent. A determination is made of the excitation and gain parameters, the level of spontaneous noise, and the sensitivity of a quartz fiber amplifier activated with Nd^{3+} . The high heat-resistance of quartz fibers activated with Nd^{3+} in conjunction with their specific light-emitting properties demonstrate the possibility in principle of creating miniature cw laser units. In the experiment described here, from which these conclusions are drawn, a fiber in the form of a helix is

placed in a cylindrical reflector inside of which there is an ISPT-6000 pumping tube. The amplification factor is measured with a two-channel system, making it possible to take into account the operating instability of the master laser. The signal from an LTI-1 laser is split in two, into the main signal and reference signal. The reference beam is fed directly to a photoreceiver with an interfering light filter placed in front of it. The main beam passes through the quartz fiber amplifier and then encounters the input of a second photoreceiver which also has a light filter placed in front of it. After amplification the electrical signals from both photoreceivers are fed to a recording oscillograph. Triggering of the master laser and system for pumping the quartz fiber amplifier is synchronized with a G5-4B oscillator. The magnitude of the amplification factor is determined in the form of the ratio of the signal at the output of the fiber amplifier when pumping. The amplification factor measured was $6.2 \times 10^{-2} \text{ cm}^{-1}$. The level of spontaneous noise was not too high. The sensitivity of this amplifier in terms of the minimal signal power at its input was $9 \times 10^{-9} \text{ W}$ with a signal-to-noise ratio of 10. Figures 2; references 12: 9 Russian, 3 Western.

USSR

UDC 551.46

USE OF A CO₂ LASER FOR REMOTE INDICATION OF POLLUTION OF WATER WITH OIL

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 4 No 4, Apr 77 pp 911-913 manuscript received 9 Sep 76

KROPOTKIN, M. A., and SHEVELEVA, T. YU., Leningrad Electronic Engineering Institute imeni V. I. Ul'yanov (Lenin)

[Abstract] A description is given of a lidar developed by the writers for detection and location of oil spills. The results of full-scale tests are given. The lidar system is based on a CO₂ laser. Emission from an LG-23 laser modulated at 20 Hz passes through the aperture in a flat mirror positioned at 45° to the horizon and is directed by another flat mirror toward the water surface under study. The radiation reflected by the water is directed by both these mirrors to a third mirror, this one being spherical and focusing on a radiation receiver, a BGS-2 bolometer. The lidar's recording system consists of a selective amplifier and an a.c. recorder. Tests of this arrangement were made on the Neva River, in the Liepaja Canal, and in the Baltic Sea in the area of Liepaja. It was found in testing that swells result in considerable reduction in the recording system's signal, even as much as 10- to 20-fold under specific conditions. A picture is shown of a typical recording of a signal obtained with a diesel spill created intentionally. Swells result in randomness of the signal; as a result statistical processing of experimental results is necessary. The experimental results do indicate that reliable detection of oil spills is possible using this system. The contrast at which the detector operates is approximately five, when using statistical processing of data, which is approximately equal to the contrast achieved under laboratory conditions with calm water. The amount

of contrast depends on the type of petroleum product; contrast is highest when indicating oil slicks and lowest when indicating films of gasoline. Contrast increases with an increase in the depth of the film. The minimum oil film depth detected is about two microns. Direct and reflected solar radiation, change in temperature of the ambient air, cloud cover, and slight fog have no influence on performance of the system. Nor does the time of day. The system's spatial resolution depends on the speed of the vehicle carrying the lidar and its altitude. The minimum detectable oil slick measures about 5 m long when the unit is installed aboard an airplane flying 200 km/h. On board a ship moving at 15 km/h this figure amounts to no less than 0.5 m. Use of other types of lasers is also possible, although contrast suffers by as much as two orders of magnitude, in spite of the advantages of small size and greater sensitivity with regard to photoelectric receivers. The results given here were obtained with normal incidence of laser emission on the surface of the water. Other angles can be used, making employment of a scanning beam possible. A variant was also created which allowed the second mirror to rotate around an axis positioned at 45° to the horizon, making it possible to scan within the range of 7° on either side of the normal line to the surface of the water at rates of 0.5, 1, and 2 Hz. Laboratory tests proved the feasibility of this system also. Figures 2; references 6: 5 Russian, 1 Western.

USSR

UDC 621.375.826:535.3

SELF-FOCUSING OF THE LASER BEAM AS A WHOLE IN FOCUSING OF EMISSION IN AIR

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 4 No 4, Apr 77 pp 907-909
manuscript received 1 Sep 76

GORYACHEV, L. V., GRIGOR'YEV, F. V., KALINOVSKIY, V. V., KORMER, S. B.,
LAVROV, L. M., and CHUDINOV, V. P.

[Abstract] For the purpose of making a direct observation of distortion of the profile of a laser beam brought about by self-focusing of emission in a gas, an experimental study was made of the change with time in the diameter of a laser beam in the focal plane and of the distribution of emission intensity in it while focusing the emission of a neodymium laser in laboratory air. An observation was made of collapse of the laser beam as a whole. The emission of a multimode Q-switched neodymium laser with power of 200 MW and divergence of about 5×10^{-4} rad at its half-strength level was focused in laboratory air by a spherical lens with focal length of 1, 1.5, and 3 m. An observation was made of the change with time in the cross section of the laser beam in the focal range of this lens, using an FER2-1 photoelectron recorder. Part of the beam's energy was tapped after passing through this lens by a beam splitter, thus forming and focusing two beams with identical geometry and having a power ratio of 10:1. Two additional identical lenses projected the focal spots of both beams onto the screen of the FER2-1. The power density of both beams on the screen was identical, making it possible

to record the change with time in the cross section of beams of different power simultaneously. Breakdown developed in one or more points of the field of focus measuring less than or equal to 20 microns in diameter, matching the resolution of the recording system. Photographs of the focal spot taken at even time intervals are shown for visualization of collapse of the beam as a whole. Photometric measuring revealed a growth in intensity of emission in the focal spot with a simultaneous reduction in its diameter, thus proving self-focusing of the beam. Breakdown occurred at approximately 50 W, and the beam collapsed within 3-8 ns. Estimates set the critical power for self-focusing at about 10^4 W, and the nonlinear factor, n_2 , at about 4×10^{-12} absolute units. The results obtained here confirm the previously suggested mechanism for breakdown, according to which lowering of the air breakdown threshold with an increase in the length of the focal range is explained by the influence of self-focusing of laser emission preceding breakdown. Figures 3; references 9: 5 Russian, 4 Western.

USSR

UDC 621.378.325

SELF-LOCKING OF MODES IN A LASER WITH COMBINED Q-SWITCHING

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 4 No 4, Apr 77 pp 878-880 manuscript received 21 Nov 75

AL'TSHULER, G. B., KARASEV, V. B., and SHARLAY, S. F., Leningrad Institute of Precision Mechanics and Optics

[Abstract] The most widely used method of forming ultrashort pulses of electromagnetic radiation at the present time is self-mode locking by means of phototropic shutters, which make it possible to rapidly change the Q of the laser's cavity resonator. The rate of Q-switching depends on the properties of the shutter used, the nature of the emission of the active core, and the pumping parameters. In the passive Q-switching mode the characteristics of the pulses generated depend substantially on the parameters of the phototropic shutter used. Active methods of locking eliminate the disadvantages characteristic of self-mode locking, namely, wide variance in emission onset times and nonreproducibility of the emission time structure. But active methods of locking do not make it possible to obtain pulses of minimal length, which is possible with passive self-mode locking. This paper examines one method of using a combined method of controlling the Q to unite the positive aspects of both the active and passive methods. A study is made of the feasibility of achieving self-mode locking in a neodymium glass laser while controlling the resonator's Q by means of a combination of phototropic and optico-mechanical shutters. A diagram of the experimental setup is given. A solution of dye No 3955 in a mixture of ethyl and isobutyl alcohol was used as the phototropic shutter, with 70 percent initial transmission. It is demonstrated that it is possible to achieve self-mode locking only after installing an additional mirror with a 30 percent reflection factor in the cavity. When this was done a characteristic dependence of stimulated emission on the magnitude of the pumping energy was observed. With combined Q-switching total self-

mode locking can be achieved only with specific magnitudes of pumping energy, in a region in which only a monopulse is generated or a train of eight to 15 ultrashort pulses. The time of emission onset coincides with the moment the prism reaches the position of alignment, representing stabilization. Reproducibility of this synchronization between position of the prism and emission onset time is within the range of 40 ns. The results of this study can be used to optimize the parameters of ultrashort pulse lasers, particularly in the single-pulse mode. Figures 1; references 5: 3 Russian, 2 Western.

USSR

UDC 621.378.325:533.03

MEASUREMENT OF GAS DYNAMIC PRESSURE AT THE TARGET UNDER THE EFFECT OF CO₂ LASER EMISSION

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 4 No 4, Apr 77 pp 837-843 manuscript received 5 Jul 76

BOYKO, V. A., DANILYCHEV, V. A., DUVANOV, B. N., ZVORYKIN, V. D., KHOLIN, I. V., and CHUGUNOV, A. YU., USSR Academy of Sciences Physics Institute imeni P. N. Lebedev, Moscow

[Abstract] This paper gives the results of measurements of pressure at the target under the effect of powerful (flux density of 10^7 to 10^9 W/cm²) CO₂ laser pulses, with the pressure of the ambient air varying from a 7×10^{-2} mm Hg vacuum to normal pressure of about 760 mm Hg, and under conditions of one-dimensional gas dynamic motion of the plasma. The targets used were a lead disk 10 mm in diameter and 0.7 mm thick and aluminum and titanium foils, 0.15 and 0.05 mm thick, respectively, cemented to the lead disk. Pressure was measured with a piezoelectric pickup utilizing a quartz crystal and functioning in the current measuring mode. The target was in acoustical contact with the quartz crystal. An insufficiently great diameter-to-thickness ratio for the piezoelement was responsible for a margin of error in measuring pressure of no better than 30 to 40 percent. The area of the focusing spot varied from 0.5 to 3 cm². Characteristic oscillograms are shown for the pressure at the target with steady power density at the target and varying pressure of the ambient air. A change in the form and amplitude of the pressure pulse at the target was observed in going from a vacuum to normal air pressure. Pressure at the target did not depend on the area of the focusing spot, neither in vacuum nor in air. Pressure at the target in air did not depend on the material of the target. Pressure at the target increased with an increase in flux density more rapidly in vacuum than in air. Experimental results are compared with a theoretical calculation for two-dimensional gas dynamic motion. On the basis of the experimental data obtained it is concluded that in interaction between CO₂ laser emission and a target in air the pressure on the surface of the target is due to a gas dynamic laser emission absorption wave in the air, and not to vaporization of the target's material, as was suggested in an earlier study. This absorption wave is propagated through the air from the target and toward the incident radiation from the laser.

Pressure at the target in vacuum is determined by evaporation of the material of the target. There are no traces of erosion on the surface of the target in air. The point of transition from one mode of action to the other is at a pressure of approximately 80 mm Hg. At this pressure an abrupt increase in pressure at the target and a change in the form of the pressure pulse are observed, proving a transition to another mechanism for interaction between the laser emission and the target. At this point the air ionizes and partly absorbs the incident radiation and shields the target, and the effectiveness of this shielding effect is reduced with lowering of air pressure, resulting eventually in erosion of the target. Figures 4; references 25: 12 Russian, 13 Western.

USSR

UDC 621.375.8:533.9.08

HIGH-SPEED MULTIFRAME INTERFEROMETRY WITH A LASER BEAM

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ZAKHARENKOV, YU. A., RODE, A. V., SKLIZKOV, G. V., FEDOTOV, S. I., and SHIKANOV, A. S., USSR Academy of Sciences Physics Institute imeni P. N. Lebedev, Moscow

[Abstract] This paper describes a method which has been developed for multi-frame interferometry of a laser plasma utilizing as the illumination source for the interferometer laser emission with a pulse length of less than 1 ns synchronized with a heating pulse with a margin of error in synchronization of less than 1 ns. High-speed interferometry makes it possible to determine the spatial distribution of the plasma's electron density within the range of 10^{17} to 10^{26} cm^{-3} . According to this method a laser beam is used to probe the plasma as an improved method of diagnosis. A description and diagram are given of the experimental setup used. To heat the plasma a 9-channel Kalmar laser unit was used, with maximum energy of 200 J, using nine beams, and a pulse length of about 1.5 ns. Part of the energy of the heating emission, about 0.2 J, was fed in the preliminary booster stages to an MKP crystal, converting about 20 percent of the emission energy at wavelength 1.06 microns into the second harmonic (0.53 micron). The light pulse at this wavelength was used for shadow photography of shock waves propagated in the atmosphere of the residual gas in the vacuum chamber and for illumination of the interferometer in synchronism with the pulse of a ruby laser operating in the pulse mode. Formation and synchronization of the probing pulse are described in detail. Methods of synchronizing two lasers differing in principle are compared in light of their respective ranges of application. A description is given of the optical system used to record interferograms. The light pulse from the ruby laser is fed to beam splitter by means of which seven frames are formed which are separated in space and time. The optical system for the multiframe interference-pattern camera consists of a lens, light

filters, a dividing prism, alignment mirrors, and photoplate holders. Experimental interferograms are shown of breakdown of air near the target and of the laser plasma in spherical irradiation of a glass microsphere. The use of multi-frame interferometry has become absolutely necessary since it is necessary to take into account the degree of symmetry of the plasma formed when analyzing slit interferograms. Also, interferometric measurements of the radial distribution of the electron density of the plasma are used in studying the initial stage in formation of shock waves in the gas surrounding the target. The method and equipment described here make these measurements possible. Figures 5; table 1; references 11: 8 Russian, 3 Western.

USSR

UDC 621.373.8.038.823

PHOTOIONIZATION IN A PULSED CO₂ LASER

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 4 No 4, Apr 77 pp 809-814 manuscript received 25 Jun 76

BORISOV, V. M., GLADUSH, G. G., and STEPANOV, YU. YU.

[Abstract] A booster discharge in the form of a plane or extended source of UV radiation is used in actual electronic discharge laser systems to obtain a cavity discharge in a CO₂-N₂-He mixture. It is necessary to measure the density of electrons in the photoplasma with these sources to make calculations of the characteristics of lasers and boosters and to explain the mechanism of formation of photoelectrons. In this paper a measurement is made of the concentration of photoelectrons in He and N₂ and in mixtures of CO₂-N₂-He from a plane source of UV radiation which would make possible a cavity discharge in a real pulsed CO₂ laser. The UV radiation source used is a surface discharge through the multigap structure of a plane electrode, with a surface discharge area measuring 200 X 300 cm. The density of photoelectrons was determined from oscillograms of the current passing between measuring electrodes carrying DC voltage, by applying Ohm's law. A diagram of the experimental setup is shown. Experimental curves are shown, expressing the relationship between the concentration of photoelectrons and the distance from the plane source of UV radiation in He, N₂, and a mixture of them with CO₂. It was found that easily ionized impurities in the gas have a substantial influence on the concentration of photoelectrons. Adding organic impurities in the form of dimethylaniline and ortho- and paraxylene resulted in a substantial increase in the concentration of photoelectrons in helium and nitrogen. Impurities were added along with the active gas, part of which was pumped through liquid phases of these organic substances. It is demonstrated here by experimentation and calculation that the concentration of photoelectrons observed in laser mixtures and its behavior as a function of the distance from the source of UV radiation are determined by ionization of impurities with low ionization potential which are present in the gas, and by absorption of the emission of CO₂ molecules. The concentration of the photoplasma

can be increased by more than an order of magnitude by adding an optimum quantity of xylene or dimethylaniline to the laser mixture. Disintegration of the photoplasma is of a recombination nature with an effective recombination coefficient of about $10^{-5} \text{ s}^{-1} \text{ cm}^3$ when dimethylaniline is added. Figures 4; references 16: 9 Russian, 7 Western.

USSR

UDC 621.039.66 + 518.2

ONE METHOD OF PROCESSING EXPERIMENTAL DATA FOR SPHERICAL IRRADIATION OF LASER TARGETS

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 4 No 4, Apr 77 pp 793-799 manuscript received 18 Jun 76

MAGNITSKIY, N. A., and MAGNITSKIY, S. A., USSR Academy of Sciences Physics Institute imeni P. N. Lebedev, Moscow, and Moscow State University imeni M. V. Lomonosov

[Abstract] The role of noncontact methods of plasma diagnosis has increased considerably in recent times after the beginning of work on laser controlled thermonuclear synthesis. The plasma formed under the effect of high-power laser emission is distinguished by its small size, rapid rate of dispersion, short lifetime, and high temperature and density. Noncontact methods of diagnosis make it possible to determine parameters of the plasma such as its density, electronic and ionic temperature, distribution of electric and magnetic fields, electron and ion energy distribution functions, and degree of turbulence. The signal directly measured in these methods is the result of summation of the contributions of separate sections of the plasma along the line of observation. The recorded signal is usually integrated with respect to time, owing to the finite time resolution of measuring equipment. The equation used in data analysis is a Fredholm's integral equation of the first kind, reflecting a three-dimensional coordinate function averaged for the observation period and describing the spatial distribution of the plasma parameter being studied, the boundaries of the plasma flare averaged over time, and the line along which the observation was made. This equation is transformed into a different form for the case when the plasma formation has spherical symmetry, which has been achieved experimentally when using high-power lasers. This equation in turn is converted into still another form which is standard for problems in processing experimental data involved in diagnosing a laser plasma. This standard equation can be reduced to Abel's equation, which reduces to a Volterra integral equation of the first kind. It is demonstrated in this paper that methods currently used to solve this equation are based on incorrect formulation of the problem of finding a solution, in that the solution is unstable with respect to the right side of the equation. A new algorithm is suggested here for solving the problem and avoiding this shortcoming. It is compared with existing methods. An example is given of implementation of this method in calculating the parameters of a laser plasma whose distribution functions have different degrees of

smoothness. The new algorithm has been implemented in the form of a program written in ALGOL. It can be run in about five minutes on an M220 computer. The algorithm has been tested by means of numerical test calculations for functions of different classes of smoothness. Results of these tests are shown. In using this method in specific instances it would be helpful to have a priori information on the distribution of the parameter of the plasma under study. Figures 3; references 23: 22 Russian, 1 Western.

USSR

THE 'INTERFACIAL TRANSMISSION WAVE' OCCURRING WHEN A LASER BEAM PULSE ACTS ON AN ALUMINUM TARGET, AND THE CONDITIONS FOR ITS EXISTENCE

Leningrad FIZIKA TVERDOGO TELA in Russian Vol 19 No 7, Jul 77 pp 1966-1968
manuscript received 13 Sep 76, after correction 27 Dec 76

SHILOV, YU. I.

[Abstract] Based on indirect experimental data a previous study had hypothesized the existence of a new effect--an "interfacial transmission wave" at whose front the liquid metal is converted into a liquid dielectric--which occurs under the effect of a laser beam pulse whose strength exceeds a certain critical value on the surface of certain metal targets. Recently this effect has been detected directly, and it has been shown to occur within a rather narrow range of laser beam strength. This paper makes a precise determination of the upper limit of this strength, whereby the effect begins to weaken in the case of an aluminum target, owing to occurrence of considerable residual ionization in the layer of liquid dielectric behind the front of the "interfacial transmission wave." The optical properties of a material are characterized by parameter ξ , representing the imaginary part of the dielectric constant, which depends on the density, N_e , of conduction electrons. Residual ionization in the liquid dielectric layer behind the interfacial transmission wave front is determined by the effective temperature of free electrons, which depends on the strength of the laser beam. With an interfacial transmission wave parameter ξ is less than unity. Therefore, the upper limit of the laser beam's strength is that value whereby the density of conduction electrons in the state of equilibrium established behind the front of the interfacial transmission wave equals $N_{ep} = 10^{21} \text{ cm}^{-3}$. For this density ξ equals unity. An increase in strength shifts the equilibrium in the direction of an increase in N_{ep} , ξ becomes greater than unity, and formation of the dielectric phase at the wave front takes place ineffectively, owing to an abrupt increase in reflection from the surface of the film and absorption of energy in the interfacial transmission layer. The relationship between ξ and beam strength is found by simultaneous solution of the equation for the dependence of the mean kinetic electron energy on the strength of the laser beam and the equation for the density of free electrons. The upper limit of beam strength for existence of the effect is found to be

$5 \times 10^8 \text{ W/cm}^2$. Its lower limit is approximately 10^6 W/cm^2 . The upper limit is considerably lower than what was thought to be the case previously. Another condition for existence of the interfacial transmission wave is that the time for approaching equilibrium must be less than the time for growth of the leading edge of the pulse. A formula is given for calculating this time. It is found to be two orders of magnitude below the typical time for growth of the leading edge of real pulses. References 6 (Russian).

USSR

UDC 621.375.82

INFLUENCE OF INHOMOGENEITIES IN FLOW PARAMETERS ON CHARACTERISTICS OF THE ACTIVE MEDIA OF CO_2 AND N_2O GAS DYNAMIC LASERS

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 4 No 4, Apr 77 pp 787-792 manuscript received 17 Jun 76

BIRYUKOV, A. S., SERIKOV, R. I., STARIK, A. I., and SHELEPIN, L. A., USSR Academy of Sciences Physics Institute imeni P. N. Lebedev, Moscow

[Abstract] In real laser systems it is necessary to study the role played by nonuniformity of kinetic and gas dynamic parameters over the cross section of the stream, for in the process of expansion of the gas through a nozzle or slit the rate of formation and magnitude of inverse population density in other stream filaments can differ substantially from those of the central filament. Previous studies have indicated that the efficiency of CO_2 and N_2O gas dynamic lasers is comparable under specific conditions. Using the example of a nozzle with a flat profile, it is demonstrated in this paper that in taking the two-dimensional nature of the stream into account considerable nonuniformity is observed in the gain characteristics of gas media with respect to the height of the nozzle in individual gas dynamic lasers. It is demonstrated furthermore that with identical initial conditions for the retarded flow before the nozzle (gas composition, temperature, and pressure) and with identical nozzle geometry the extent and nature of the influence of inhomogeneities in flow parameters differ for CO_2 and N_2O systems. Non-equilibrium parameters of the gas were found by integrating gas dynamics and oscillatory kinetics equations for inviscid core of the stream along several stream filaments. A system of equations is given which describes the flow of a relaxing gas along a specific stream filament with known distribution density over the length of the nozzle. An analysis is made for a specific flat nozzle with a geometrical expansion ratio of 16, a subsonic section with a 90°V -type inlet, and a critical section height of 1 mm. Diagrams of the subsonic, transonic, and supersonic sections of the nozzle are shown. Five stream filaments are isolated for analysis with respect to these nozzle sections, including the axial and wall filaments. A computation was made for the distribution of gain in the active media with respect to the X axis of this nozzle. These media consisted of mixtures of CO_2 (or N_2O), N_2 , and He, in a ratio of 1:4:5. Initial parameters of the retarded flow before the nozzle were identical, with a temperature of 1000°K and pressure of 5 atm. A

one-dimensional calculation is also made of distribution of vibrational temperatures and the gas temperature, the difference in population densities of levels 00^0_1 and 10^0_0 of CO_2 and N_2O molecules, and gain characteristics of the mixtures used. Results are shown graphically. A distinguishing feature of the N_2O system is a characteristic growth in the temperature of asymmetric vibrations beyond the critical section for the flow, which is caused by non-resonant vibrational interchange with N_2 . Considerable nonuniformity in parameters shows a great influence on formation of inverse population density as early as the critical section of the nozzle. There is a difference in the distributions of the common vibrational temperature for symmetric and deformation vibrations, and of the temperature for asymmetric vibrations for molecules of CO_2 and N_2O . The different rates of processes of oscillatory energy exchange in CO_2 and N_2O mixtures and the different nature of their flow beyond the critical section result in a marked difference in distribution of gain characteristics for these media in different stream filaments. Distribution curves are shown. For CO_2 maximum values of the gain characteristic are reached in the wall filament of the stream, whereas this filament shows minimal gain for NO_2 under certain conditions. For an inviscid thermally nonconductive gas non-uniformity of gain characteristic values over the nozzle's cross section can reach 20 to 30 percent of the maximum gain under certain conditions. The two-dimensional nature of the flow must be taken into account for optimizing the shape of a gas dynamic laser nozzle in the general situation in which arbitrary active media are employed, especially in the case of short relaxation periods. The one-dimensional approach is generally not suitable here. Figures 6; references 16: 14 Russian, 2 Western.

USSR

UDC 539.12

LIMITATIONS ON EFFICIENCY OF FREQUENCY CONVERSION IN REFLECTION OF ELECTROMAGNETIC WAVES FROM CLUSTERS OF RELATIVISTIC ELECTRONS OR MOVING PLASMA

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STOLYAROV, S. N.

[Abstract] The general question with which this paper is concerned is that of obtaining high-power coherent emission in the UV, x-ray, and gamma-ray bands. One possibility discussed is the method of converting optical phonons in Compton backscattering by relativistic electrons. Modern accelerators have made it possible to generate beams of relativistic electrons with energy of 1 to 2 MeV and current density of 10^6 A/cm^2 , representing considerable concentration of electrons in the cluster as great as 10^{15} cm^{-3} . This paper is concerned with the type of frequency conversion entailed in reflection of electromagnetic waves from an interface with a cluster of electrons or a plasma moving toward it. This represents the phenomenon of coherent scattering of an electron beam, whereby the intensity of the scattered radiation is

proportional to the square of the concentration of electrons in the cluster. It is demonstrated in this paper that when waves are reflected from moving clusters considerable limitation is imposed on the efficiency of conversion in the short wavelength region by the finiteness of the dimension of the leading edge of the growth in concentration of electrons in these clusters, i.e., by the imprecision or "fuzziness" of the interface at the leading edge of the cluster. This fuzziness is substantial both with respect to the incident and reflected wave, and the length of the reflected wave is considerably shorter than that of the incident. This limitation is pointed out for the first time in this paper. An illustration is given of an exact solution to the problem of reflection from a beam of relativistic electrons with an exponential change in the concentration of electrons at the leading edge of the cluster, as well as approximate analytical formulas for a profile of arbitrary form. It is demonstrated analytically that the feasibility of obtaining high-power UV, x-ray, or gamma-ray emission by reflection of intense laser emission from dense clusters of relativistic electrons is severely restricted by fuzziness of the interface for real clusters, with regard to the short wavelengths of the reflected radiation. Formulas obtained here show that electron beams with energy of about 8 MeV and current density of about 10^{14} A/cm² are necessary for sufficiently efficient transformation of waves from the optical band (wavelength of approx. 10^{-4} cm) into the strict x-ray band (wavelength of approx. 10 \AA). The current rise time at the leading edge of the beam should not exceed 10^{-18} s. Beam parameters of this sort are beyond the reach of technical feasibility at the present time. The formulas given here can be used to estimate beam parameters required for efficient conversion into other wavelength ranges. References 19: 16 Russian, 3 Western.

USSR

UDC 535.24:535.343.4:551.521.3:621.375.826

MOLECULAR ABSORPTION OF CO₂ LASER EMISSION IN THE TROPOSPHERE IN STABLE ANTICYCLONE SITUATIONS

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manuscript received 24 Sept 76

AREF'YEV, V. N., and DIANOV-KLOKOV, V. I., Institute of Experimental Meteorology, Obninsk

[Abstract] A technique is given for calculating the attenuation of CO₂ laser emission ($\lambda = 10.6 \text{ \mu m}$) by atmospheric water vapor and carbon dioxide for horizontal and vertical paths. It is shown that on vertical paths of more than 2 km and on horizontal paths in the winter attenuation due to carbon dioxide predominates. The main contribution to attenuation on horizontal paths in the summer comes from water vapor. Under the conditions of the troposphere on vertical and horizontal paths in the winter it may be more advantageous to use CO₂ lasers that operate on lines different from P20 of transition 00⁰₁-10⁰₀ of the main isotope of carbon dioxide or on lines of the minority isotope

of CO_2 since the coefficient of resonant absorption is lower in the first case, and the isotope content in the air is low in the second. The gain from such a substitution will be low in summer on horizontal paths. Figures 3; references 14: 10 Russian, 4 Western.

USSR

UDC 533.9.15

THE INFLUENCE THAT RESONANT EXCITATION OF ROTATIONAL LEVELS HAS ON THE ENERGY BALANCE IN A GAS DISCHARGE PLASMA IN MIXTURES OF N_2 , CO, CO_2 AND He

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 4 No 6(60), Jun 77 pp 1359-1360
manuscript received 28 Jul 76

KONEV, YU. V., KOCHETOV, I. V., MARCHENKO, V. S., and PEVGOV, V. G., Moscow Physicotechnical Institute

[Abstract] On the basis of a numerical solution of the Boltzmann's equation for the electron energy distribution function the authors calculate the energy balance of electrons in pure N_2 , and also in mixtures of $\text{CO}_2:\text{N}_2:\text{He} = 0.05:0.85:0.1$ and $\text{CO}:\text{N}_2 = 0.1:0.9$. It is shown that for a low value of $E/N \leq 10^{-16}$ V/cm² in nitrogen-rich mixtures it is necessary to account for the resonant excitation of rotational levels of nitrogen. Figures 4; references 12: 3 Russian, 9 Western.

USSR

UDC 621.378.325

ON THE STABILITY OF SINGLE-MODE LASING ACTION

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 4 No 6(60), Jun 77 pp 1353-1356
manuscript received 6 Jul 76

LIKHANSKIY, V. V., and NAPARTOVICH, A. P.

[Abstract] The authors consider the influence that nonhomogeneity of the medium and the geometry of the cavity have on the stability of single-mode laser emission. They disregard the possible small-scale nonhomogeneity of gain, which is usually considered one of the principal causes of multimodality. It is shown that in the absence of burnout of spatial and spectral holes, the single-mode laser action may be unstable if the inhomogeneity of the distribution of losses in the cavity is taken into account. A formula is derived for the increment in the development of instability assuming low light amplification per pass with consideration of the dispersion of gain. It is shown

that in the general case there are two thresholds with respect to pumping power, i.e., single-mode emission is unstable when the value of the pumping rate falls into a certain interval that depends on the parameters of the cavity and the medium. References 4 (Russian).

USSR

UDC 621.378.33

INVESTIGATION OF OPTICAL INHOMOGENEITIES IN CHEMICAL LASERS

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 4 No 6(60), Jun 77 pp 1336-1340
manuscript received 9 Sep 76

ZYKOV, L. I., KIRILLOV, G. A., KORMER, S. B., NIKOLAYEV, V. D., and SUKHARFV, S. A.

[Abstract] Interference methods were used to study the change of indices of refraction Δn in the active media of chemical lasers on F_2+D_2+He (CO_2 ; SF_6) with pumping by the light of a xenon flash tube. It is shown that 80-90% of the energy is emitted by the laser when the active medium is optically homogeneous ($|\Delta n| \sim 2 \cdot 10^{-7}$), and the change that shows up in the index of refraction at the end of stimulated emission does not exceed $(0.7-1.5) \cdot 10^{-6}$. The behavior of Δn varies depending on the concentration of the main reagents: in weakly concentrated mixtures the index of refraction decreases relatively slowly, while in more concentrated mixtures it rises sharply for 0.5-1 μs before the end of lasing action. It is assumed that the change in the index of refraction is caused by gasdynamic displacements of the medium due to nonuniform heating as a result of the chemical reaction. It is shown that a chemical reaction between fluorine and deuterium has a decisive influence on optical nonhomogeneities. Figures 5; table 1; references 5 (Russian).

USSR

UDC 621.378.325

THE PROCESS OF OUTPUT BEAM SHAPING IN A PULSED GAS LASER WITH UNSTABLE CAVITY

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 4 No 6(60), Jun 77 pp 1325-1335
manuscript received 2 Aug 76

ISAYEV, A. A., KAZARYAN, M. A., PETRASH, G. G., RAUTIAN, S. G., and SHALAGIN, A. M., Physics Institute imeni P. N. Lebedev, Academy of Sciences USSR, Moscow, Institute of Spectroscopy, Academy of Sciences USSR, Moscow

[Abstract] In previous research by these authors it was experimentally shown that the use of an unstable cavity with large values of gain gives output beams with diffraction divergence in lasers that have short inversion duration and high amplification. Subsequent papers dealt with theoretical analysis of output beam shaping with diffraction divergence from incoherent spontaneous emission for an arbitrary unstable cavity. The purpose of this paper is further experimental investigation of the properties of a pulsed copper vapor laser with unstable cavity, and comparison of the results with theoretical conclusions. The research was done for different levels of excitation of the active medium over a wide range of variation of the amplification. Figures 5; table 1; references 8: 7 Russian, 1 Western.

USSR

UDC 621.378

LASER AMPLIFIER RECEPTION OF SCATTERED RADIATION

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 4 No 6(60), Jun 77 pp 1318-1324
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BELONUCHKIN, V. YE., YESKIN, N. I., KOZEL, S. M., KUZNETSOV, YE. P., and LOKSHIN, G. R., Moscow Physicotechnical Institute

[Abstract] The paper presents the theory of signal passage through a single-pass laser amplifier for the case of a spatially random signal that arises when coherent emission is scattered. Consideration is given to the need of accounting for the effect of canalization of emission by the walls of the gas discharge cell. The problem of spatial selectivity of the laser amplifier is examined. It is shown that the optimum size of the aperture of the reception system with a single-pass amplifier may be considerably greater than the radius of spatial coherence. Estimates of the gain are found for the scattered emission. The theoretical conclusions are experimentally confirmed. The results indicate a good outlook for a photoreceiver system with single-pass laser amplifier when receiving scattered emission on wavelengths of 3.39 and 3.51 μm . The authors thank I. P. Mazan'ko for interest in the work and constructive discussions. Figures 4; references 10: 9 Russian, 1 Western.

USSR

UDC 539.3+539.6+621.039.66

INVESTIGATION OF A PLASMA MIRROR OF AN ELECTRON BEAM-CONTROLLED CO₂ LASER
OVER A RANGE OF FLUX DENSITIES OF HEATING RADIATION OF 10^{11} – 10^{12} W/cm²

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 4 No 6(60), Jun 77 pp 1307–1312
manuscript received 1 Oct 76

BOYKO, V. A., DANILYCHEV, V. A., ZVORYKIN, V. D., IVANOVA, T. G., KHOLIN, I. V., and CHUGUNOV, A. YU., Physics Institute imeni P. N. Lebedev, Academy of Sciences USSR, Moscow

[Abstract] The authors study the parameters of the plasma mirror of an electron beam-controlled laser. It is shown that when an electron beam-controlled CO₂ laser is operating in a simple arrangement with plasma mirror, the energy of the laser emission is effectively absorbed in the plasma. When the power of the heating radiation is of the order of tens of gigawatts and the flux density on the target is 10^{11} – 10^{12} W/cm² the temperature and density of electrons in the plasma mirror as measured by x-ray spectroscopy methods were $T_e \sim 200$ eV and $N_e \sim 10^{19}$ cm⁻³. Helium-like MgXI ions were produced. The authors thank N. G. Basov for interest in the work, and V. A. Kovalenko, S. A. Pikuz and A. Ya. Fayenov for cooperation in working out the diagnostic techniques and for constructive criticism. Figures 5; tables 2; references 23: 16 Russian, 7 Western.

USSR

UDC 628.378.33+621.373.826.038.823

INFLUENCE OF PRINCIPAL FACTORS ON THE EFFICIENCY OF COHERENT EMISSION IN THE
PROCESS OF REACTION OF HYDROGEN WITH FLUORINE

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 4 No 6(60), Jun 77 pp 1282–1295
manuscript received 22 Jul 76

IGOSHIN, V. I., NIKITIN, V. YU., and ORAYEVSKIY, A. N., Physics Institute imeni P. N. Lebedev, Academy of Sciences USSR, Moscow

[Abstract] A relatively simple kinetic model of a fluorine-hydrogen laser is developed that takes account of the salient features of physicochemical kinetics and enables calculation of the specific energy yield and duration of coherent emission, effective length of the chain of reaction of fluorine with hydrogen, and the chemical and technical efficiency both for an amplifier and for a laser. This model is used to study the influence that basic factors--pressure and chemical composition of the mixture, spectral makeup of the emission, intensity and duration of initiation--have on the working efficiency of a laser operating in the amplification mode. The dynamics of emission and the specific energy characteristics of the laser are also calculated. The results give an idea of the specific energy yield of coherent emission in the

process of reaction of hydrogen with fluorine over a wide range of initial parameters and enable one to choose the optimum working conditions for a laser-amplifier system. Figure 1; tables 7; references 19: 12 Russian, 7 Western.

USSR

UDC 535.41:536.76

PHASE TRANSITION IN LASER SHAPING OF SPATIALLY COHERENT BEAMS

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 4 No 6(60), Jun 77 pp 1268-1275
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PAKHALOV, V. B., and CHIRKIN, A. S., Moscow State University imeni M. V. Lomonosov

[Abstract] A detailed analysis is done on research on the spatial correlation functions of beams produced by a laser working below the emission threshold as a function of operating conditions. The experimental results are interpreted in terms of a theory developed for a Fabry-Perot resonator filled with an amplifying medium. Data are given on the change in the radius of spatial coherence r_{cor} and the intensity I of the emission as the lasing threshold is approached. It is shown that their behavior conforms to the law $r_{\text{cor}} \sim (\delta - \delta_l)^{-\alpha}$ and $I \sim (\delta - \delta_l)^{-\beta}$, where δ_l represents the losses at which stimulated emission arises, α and β are critical exponents. Measurements done on a helium-neon laser give values of $\alpha = 0.49 \pm 0.05$ and $\beta = 0.9 \pm 0.2$, which agrees with the values $\alpha = 0.5$, $\beta = 1.0$ given by the theory of spatial coherence in lasers based on the wave approach. The agreement between the experimental results and Landau theory for phase transitions of the second kind is discussed. The authors thank S. A. Akhmanov, R. L. Stratonovich and G. I. Surdutovich for constructive criticism, and F. M. Yusubov for assistance with the experiment. Figures 4; references 16: 10 Russian, 6 Western.

RECOMBINATION LASERS BASED ON VAPORS OF CHEMICAL ELEMENTS. II. STIMULATED EMISSION ON ION TRANSITIONS OF METALS

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 4 No 6(60), Jun 77 pp 1257-1267
manuscript received 21 Jul 76

ZHUKOV, V. V., KUCHEROV, V. S., LATUSH, YE. L., and SEM, M. F., Rostov State University

[Abstract] So far, stimulated emission of coherent radiation in the recombination mode has been achieved mainly on ion transitions of metals. In this paper the authors examine mechanisms of lasing action on some of these transitions from the standpoint of the principles of population inversion in the plasma recombination process that were elucidated in part I of this work [Kvantovaya Elektronika, Vol 4 No 6, 1977 pp 1249-1256]. Transitions on strontium, calcium, beryllium, aluminum, tin and lead are considered from the standpoint of general requirements for the arrangement of levels and discharge conditions. The principal emphasis is placed on a strontium vapor laser. Inversion is calculated on a transition with wavelength of 430.5 nm in SrII with consideration of radiational and collisional transitions between levels. The authors emphasize the part played by de-exciting collisions with slow electrons and depopulation of the lower laser level. The calculation is given with the results of experiments on determining the electron temperature in the afterglow of a gas discharge in mixtures of metal vapors with inert gases. An increase in electron temperature is observed with a rise in metal vapor pressure; an explanation is given for this effect. An average power of 0.5 W is achieved on a wavelength of 373.7 nm in CaII, and 1 W on 430.5 nm in SrII vapor with pulse recurrence rate of 5 kHz and efficiency of 0.1-0.14%. The position of working levels of new recombination lasing transitions in the ion spectra of Be, Al, Sn and Pb is examined. Figures 7; references 14 (Russian).

RECOMBINATION LASERS BASED ON VAPORS OF CHEMICAL ELEMENTS. I. PRINCIPLES OF ACHIEVING STIMULATED EMISSION IN THE RECOMBINATION MODE

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manuscript received 21 Jul 76

ZHUKOV, V. V., LATUSH, YE. L., MAKHALEVSKIY, V. S., and SEM, M. F., Rostov State University

[Abstract] On the basis of recent experiments with operating recombination lasers the authors formulate specific requirements for discharge conditions and the positions of working levels of atoms and ions needed to achieve population inversion during the plasma recombination period, examine the mechanisms that are responsible for inversion in existing recombination lasers, and point out the advantages of lasers of this type. It is shown that efficient pumping of working levels by radiation-impulse recombination requires high plasma densities, rapid and deep cooling of the electron gas following the current pulse, and utilization of doubly ionized particles with a high initial concentration. It is most convenient to use recombination in the afterglow of a discharge in readily ionized elements vaporized with helium. Since the transitions between levels due to electron de-excitation are appreciable in the period of plasma relaxation, requirements are worked out for arrangement of laser transitions in the approximation of groups of levels. A generalized criterion is derived for the existence of inversion. Individual consideration is given to cases of radiational and collisional modes in the case of widely spaced levels. General requirements are formulated on the positions of levels to achieve inversion under conditions of recombination-collisional kinetics: 1) the upper laser level must be one of the lower levels in the upper group of closely spaced levels; 2) the lower laser level must be one of the upper levels in the lower group of closely spaced levels; 3) it is desirable that the transitions between levels be allowed transitions; 4) the electron concentration must be high enough so that the probability of collisional transitions within the groups will exceed the probability of optical transitions; 5) the level of the electron temperature must be as low as possible. Figures 2; references 9 (Russian).

USSR

UDC 535.2

CONCERNING THE INFLUENCE OF VIBRATIONAL RELAXATION ON THE ENERGY CHARACTERISTICS OF A LASER PULSE IN A MOLECULAR AMPLIFIER

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 4 No 6(60), Jun 77 pp 1243-1248
manuscript received 6 Jul 76, after final revision 14 Jan 77

BOGDANOVA, M. V., IL'INOVA, T. M., MARKANO, A. O., and MEDVEDEV, G. N., Moscow State University imeni M. V. Lomonosov

[Abstract] The diffusion approximation is used in studying the energy characteristics of a laser pulse in a molecular amplifier with two electron states. The calculation is done on the following assumptions: 1) the molecules of the medium are approximated by harmonic oscillators with identical natural frequencies in the free and excited electron states; 2) only vibrational-translational relaxation is considered; 3) the signal has the frequency of the electron transition; 4) interaction between the pulse and the medium is incoherent; 5) the lifetime of the excited electron state is great enough that relaxation processes due to the transition to the ground state can be disregarded. It is shown that multiple-level amplifiers with vibrational relaxation can be used as both power and energy amplifiers. Figures 2; references 11: 7 Russian, 4 Western.

USSR

UDC 621.372.82

INVESTIGATION OF A SPECTRALLY INHOMOGENEOUS ACTIVE MEDIUM BY EXPOSURE TO AN EXTERNAL GIANT PULSE

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 4 No 6(60), Jun 77 pp 1237-1242

ABURABYA, ALI MAKHER, GODENKO, L. P., and MASHKEVICH, V. S., Institute of Physics, Academy of Sciences UkrSSR, Kiev

[Abstract] One way to study the microparameters of spectrally inhomogeneous laser media is to expose them to an external giant pulse in the stimulated-emission mode. A giant pulse that is shorter than the time of cross relaxation, spontaneous emission and pumping "cuts off" stimulated emission. After a certain delay time, pumping restores emission on a frequency that differs from the initial frequency of stimulated emission. If a relation can be established between the delay time and the frequency of emission onset on the one hand, and the homogeneous broadening of an individual center and cross relaxation rate on the other hand, then by measuring the first two parameters in an experiment, the latter two can be calculated. In this paper the problem is solved with consideration of the time dependence of quasi-equilibrium distributions of excitations in the case of glass laser media where nonhomogeneous broadening is large compared with homogeneous broadening of an individual center. References 4 (Russian).

INFLUENCE OF A LONGITUDINAL MAGNETIC FIELD ON NONRECIPROCAL EFFECTS IN A RING LASER

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 4 No 6(60), Jun 77 pp 1227-1236
manuscript received 7 May 76

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Gor'kiy

[Abstract] The authors calculate the influence that a longitudinal magnetic field applied to the active medium has on nonreciprocal effects in a ring laser with mode polarization close to linear. This problem is of interest both from the standpoint of physics and in connection with making laser gyroscopes. The calculations take account of deviation from ideality of the phase nonreciprocal device, Brewster's windows and mirrors. Application of the magnetic field is considered without regard to saturation of the active medium. A relation is found between the frequency difference and emission threshold excesses of opposed differently polarized waves, where the difference in polarization is due to imprecision in making and adjusting the cavity elements. Nonreciprocal effects are considered for the case of one and two modes. The following physical interpretation of the results is proposed. In the case where the ellipticity of the opposed waves at the entrance to the active medium differs, Zeeman splitting in the presence of a magnetic field $H_a \neq 0$ gives different gains and different phase leads for the waves. And the difference in phase leads gives a correction for the frequency difference that depends on the magnetic field and on the ellipticity difference. The gain difference takes the form of a difference in the emission threshold excess that depends on the magnetic field and on mismatch. This dependence is odd with respect to mismatch since the gain difference changes sign when it passes through zero for circular components in the center of the transition line. In the case where the defect of the nonreciprocal device is due to difference of azimuths, the opposed waves have different azimuths when they enter the active medium. With application of the magnetic field, the difference in the azimuths of the field vector prevents a phase lead or gain difference, but due to the Faraday effect there is an additional rotation of azimuths that is the same for the opposed waves. When combined with losses on the Brewster's windows, this additional rotation causes a difference between losses of the opposed waves in the cavity that is independent of the mismatch. Figures 2; references 11: 10 Russian, 1 Western.

USSR

UDC 681.142.65:778.38

POSSIBILITIES OF FAR-FIELD OPTICAL DATA PROCESSING BY USING THREE-DIMENSIONAL HOLOGRAMS

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 4 No 6(60), Jun 77 pp 1208-1214
manuscript received 29 Mar 76

GUTHER, R., and KUSCH, S., Central Institute of Optics and Spectroscopy, East German Academy of Sciences, Berlin

[Abstract] The high information capacity of three-dimensional recording media implied by the Bragg condition enables multiple recording of images on a single section of the medium. The authors discuss some possibilities of optical data processing by using multiple recording and the peculiarities of the topological structure of three-dimensional holograms. It is assumed that the signal, reference and readout waves are discrete, and that the hologram is a parallelepiped of large dimensions. Then if the direction of propagation of the signal wave is taken as the direction of readout, a change in the position of the reconstructed sources can be realized. In this way signals can be recorded and reconstructed by angular coding. Some peculiarities and limits of applicability of the technique are considered. It is shown that superimposed holograms can be used as filters in which the signal-to-noise ratio is enhanced by rotation of a hologram. The problem of associative data processing is considered. The authors thank Doctor G. Lenk, Doctor H. Schonagel, and also R. Spolachik for constructive criticism. Figures 8; tables 2; references 11: 5 Russian, 6 Western.

USSR

UDC 621.373.018.756:621.373.029.67

A MODE-LOCKED LASER FOR ULTRAWIDE-BAND COMMUNICATION SYSTEMS

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 4 No 6(60), Jun 77 pp 1203-1207
manuscript received 2 Feb 76, after revision 3 Aug 76

ZENCHENKO, S. A., LIVSHITS, M. G., and SHEVCHIK, T. I., Scientific Research Institute of Applied Physics Problems and Affiliated with Belorussian State University imeni V. I. Lenin, Minsk

[Abstract] The authors discuss questions of theoretical calculation of the zone of stable pulsed stimulated emission and phase characteristics of a helium-neon laser in mode-locked operation for generating the carrier in a high-speed optical digital communication system. It is shown that unavoidable variations in laser parameters during operation have a noticeable effect on the optimum frequency of intracavity modulation and on the value of dissipative perturbations that is required for synchronization. The slope of the phase characteristic of the mode-locked laser is inversely proportional to the magnitude of the internal perturbations. In the region of stabilized self-mode

locking, the slope of the phase characteristic is about one-third of the slope in the region of active mode-locking. An automatic control system is described that keeps mode-locked emission stable with considerable fluctuations in ambient temperature. A high-frequency phase detector generates an error signal proportional to the phase difference between optical output pulses and modulating waveforms with frequency of 85 MHz. Voltage proportional to the error signal controls the frequency of a quartz-crystal oscillator (8.5 MHz). The signal from the oscillator output goes to a frequency multiplier, a power amplifier, and is sent via a matching pi filter to the intracavity modulator. Without the automatic control system, a change in temperature by 1.5°C in 10 minutes causes a 1 ns time shift in the optical pulses. There is no such shift when the system is used, and maximum phase instability does not exceed 0.2 ns. The authors thank S. S. Shushkevich for his valuable advice and assistance in writing this paper. Figures 5; references 8: 2 Russian, 6 Western.

USSR

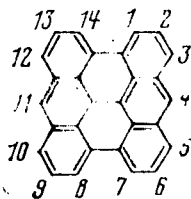
UDC 621.373.8

BISANTENES--MATERIALS FOR PHOTOTROPIC Q-SWITCHING OF RUBY LASERS

Minsk ZHURNAL PRIKLADNOY SPEKTROSKOPII in Russian Vol 26 No 6, Jun 77 pp 993-995 manuscript received 18 Jun 76

GORELENKO, A. YA., TOLKACHEV, V. A., and KHALIMANOVICH, D. M.

[Abstract] A report on a new class of organic compounds suitable for phototropic passive Q-switching of ruby lasers--bisantene derivatives:



Studies were done on 4,11-diphenylbisantene ($C_{40}H_{22}$) and 4,11-diacetoxybisantene. The first compound fluoresces with a quantum yield of fluorescence of 18% in a benzene solution. The compound is soluble in toluene, giving a molar extinction coefficient of more than 2.4 cm^{-1} at room temperature on a wavelength of 694 nm. solutions of 4,11-diphenylbisantene in toluene and xylene emit on wavelengths of 725 and 766 nm respectively when pumped by a ruby laser. A phototropic shutter based on a solution of 4,11-diacetoxybisantene in chlorobenzene gave monopulses with energy of up to 1 J, but the efficiency of the shutter is lower than for the other compound. A monopulse with half-width of 10-11 ns and emission density of about 200 MW/cm^2 is stimulated when a toluene solution of 4,11-diphenylbisantene is used, and self-mode locked operation is realized with solutions in bromobenzene. Figures 2; references 16: 7 Russian, 9 Western.

BREAKDOWN OF AIR BY PULSED CO₂ LASER EMISSION CLOSE TO A TARGET

Minsk ZHURNAL PRIKLADNOY SPEKTROSKOPII in Russian Vol 26 No 6, Jun 77 pp 983-987 manuscript received 23 Jul 76

GOLUBEV, V. S., KISELEVSKIY, L. I., and SNOPKO, V. N.

[Abstract] An investigation is made of the effect of reduced threshold intensity for breakdown of air when a solid target is placed at the focus of CO₂ pulsed laser emission. The laser had transverse discharge at atmospheric pressure with preionization corona discharge. Emission energy was measured by an IMO-2 calorimeter, and was 2.5 J. The output had a divergence of 0.03 rad, and was focused by lenses with focal lengths of 5-30 cm on solids and liquids. The glow of the resultant flares was photographed with an SFR high-speed camera and recorded by the ISP-51 spectrograph. Experiments were done on targets with very different physical properties (metals, dielectrics, liquids). The emission threshold for breakdown of air was $4 \cdot 10^8$ W/cm², which was reduced to 10^6 - $4 \cdot 10^7$ W/cm² by the introduction of a target. The least reduction in the emission threshold (to $4 \cdot 10^7$ W/cm²) was observed above the surface of alcohol and glycerin. Easily destroyed materials such as Plexiglas and Micarta also have a fairly high threshold-- 10^7 W/cm². The strongest reduction of breakdown threshold was observed for the more heat-resistant dielectrics and ground metals (porcelain, ceramic, sulfur, graphite, tungsten, copper, zinc, Duralumin). The dynamics of development and spectral characteristics of the resultant plasma were studied. An analysis of the reduction in breakdown threshold for different materials showed that primary electrons are formed chiefly by thermionic emission and thermal ionization of vapor. The relation between breakdown threshold and spot size corresponds to an avalanche mechanism of breakdown. The development of plasma formation is accompanied by repeated breakdown of the air in advance of the shock wave front. An analysis of the spectral makeup of the emission shows spatial separation of the regions of emission of lines of the atmosphere and target material. Figures 3; references 10: 7 Russian, 3 Western.

USSR

UDC 621.375.23

OPTICAL GAIN BEHIND AN AXISYMMETRIC SHOCK WAVE

Novosibirsk FIZIKA GORENIYA I VZRYVA in Russian Vol 13 No 3, May/Jun 77 pp 447-454 manuscript received 5 Jan 76

LEVIN, V. A., and TUNIK, YU. V., Institute of Mechanics, Moscow State University, Moscow

[Abstract] The authors consider the problem of population inversion of vibrational levels in a flow of $\text{CO}_2 + \text{N}_2 + \text{He}$ behind an explosive axisymmetric shock wave. An investigation is made of the way that optical gain depends on the parameters in the problem with consideration of back pressure and the finite dimensions of the region of energy release. It is shown that with a reduction of initial temperature the difference between the maximum values of gain for equilibrium and frozen boundary conditions on the shock wave propagating through the quiescent gas decreases. Gains comparable to those achieved in supersonic nozzles can be realized in an extended region behind the shock wave when the initial temperature of the undisturbed mixture is low, the dimensions of the initially excited region are small, and the parameters of pressure, energy release, gas concentrations and shock wave temperature are properly chosen. Figures 7; references 14: 12 Russian, 2 Western.

USSR

UDC 621.378.33

ON NUMERICAL ANALYSIS OF THE PROPERTIES OF A SATURATED MEDIUM IN A TURBULENT HF-CHEMICAL LASER OF DIFFUSION TYPE

Novosibirsk FIZIKA GORENIYA I VZRYVA in Russian Vol 13 No 3, May/Jun 77 pp 366-378 manuscript received 11 Jun 76

GOLOVICHIEV, V. I., and PREOBRAZHENSKIY, N. G., Institute of Theoretical and Applied Mechanics, Siberian Department, Academy of Sciences USSR, Novosibirsk

[Abstract] The paper gives numerical results that illustrate the conversion efficiency of chemical energy in supersonic chemical diffusion lasers with an injector system that provides a high mixing rate due to the difference in velocities of the reagent flows when the pressure of the working mixture in the cavity is of the order of 10-30 mm Hg. The energy characteristics of a turbulent HF-chemical laser with complete and partial dissociation of molecular fluorine in the mixer are calculated. The research includes parametric optimization of conditions of energy conversion in laser systems of this type. The analytical description of the hydrodynamics of the flow and the thermodynamic properties of the working mixture was based on laws of conservation of the phenomenological theory of a turbulent boundary layer for a multicomponent mixture of reacting gases in the form of partial differential equations of parabolic type. The effects of nonequilibrium chemical reactions with the

formation of molecules with excess energy in the form of quantum excitations were accounted for by introducing source terms in the macroscopic equations of balance of matter and energy. Figures 7; tables 3; references 17: 2 Russian, 15 Western.

USSR

UDC 539.184:621.378.325

ON THE THEORY OF INTERACTION OF A THREE-LEVEL SYSTEM WITH PUMPING FIELDS

Leningrad ZHURNAL TEKHNIЧЕСКОY FIZIKI in Russian Vol 47 No 5, May 77 pp 1036-1044 manuscript received 27 Jul 76

BATYGIN, V. V., SHOLNEROV, V. S., MATISOV, B. G., and TOPTYGIN, I. N., Leningrad Polytechnical Institute imeni M. I. Kalinin

[Abstract] A microscopic analysis is done in the interaction between a three-level system and resonant pumping fields in the rf and optical bands. The rf field is taken as monochromatic, while the optical field is assumed to be incoherent, arbitrary in spectral makeup and arbitrarily polarized. The authors calculate the probability of transitions, radiative broadening and shifts of spectral lines with consideration of the reciprocal influence of the fields. The populations of levels in the steady state contain constant components and small oscillating admixtures. The optical power absorbed by the system is modulated by the radio frequency. The depth of modulation depends on the parameters of the optical and rf fields, including their polarization, and may be near 100%. Figures 4; references 11: 5 Russian, 6 Western.

USSR

UDC 621.378.33

AN IODINE LASER CONTROLLED BY A MAGNETIC FIELD THAT USES CURRENT BREAKERS IN THE CONTROL CIRCUIT

Leningrad ZHURNAL TEKHNIЧЕСКОY FIZIKI in Russian Vol 47 No 5, May 77 pp 1033-1035 manuscript received 9 Jun 76

BELOUSOVA, I. M., BOBROV, B. D., BURTSEV, V. A., GRENISHIN, A. S., DUBYANSKIY, V. A., KISELEV, V. M., and PRODUVNOV, A. B.

[Abstract] The paper gives the results of experiments on controlling the duration of iodine laser emission pulses by using magnetic fields produced by using a foil current breaker in the electromagnet power supply circuit. The experiments were done with lasers having a cell 20 cm in diameter and 100 cm long. The design of the cell was similar to that described in a paper by J. Do-Moria and C. J. Ulfee [App. Phys. Lett., Vol 9, 1966, p 67] except that

the housing was made of a dielectric. Pumping energy of 30 kJ was supplied by a coaxial flash tube. The magnetic field was produced by discharging a capacitor bank across short solenoids. The exploding metal foil strips were connected in series with the field coils to produce the proper shape of the magnetic field pulse. The results show that emission starts at a threshold value of 0.3 T, and lasts almost until the magnetic field passes through zero for a sinusoidal magnetic pulse. When the foil current breaker is used, the magnetic pulse has a steep trailing edge and the maximum is close to the threshold value, so that the field shaping energy is much lower than in the case of a sinusoidal pulse. In addition, the emission pulse is 2.5 times shorter. The pulse can be shortened still further by improving the breaker device and using multistage breaker systems. Figures 2; references 7: 6 Russian, 1 Western.

USSR

UDC 534.29:532.783

PLASMA-ACOUSTICAL CAVITATION PHENOMENA INITIATED BY A LASER PULSE IN LIQUID CRYSTAL SYSTEMS

Kiev UKRAINSKIY FIZICHESKIY ZHURNAL in Russian Vol 22 No 6, Jun 77 pp 1039-1041 manuscript received 22 Nov 76

GOLUBNICHKIY, P. I., OLZOYEV, K. F., and FILONENKO, A. D., Voroshilovgrad Machine-Building Institute

[Abstract] Recently, sonoluminescent phenomena have been discovered upon collapse of heterogeneities initiated by laser radiation in a liquid. The present work was undertaken to detect the related plasma-acoustical phenomena in relatively complex (near biological) objects, namely liquid-crystal non-magnetic type systems. The intensity of the sonoluminescent pulses produced was 10^{-14} J, their duration less than $2 \cdot 10^{-8}$ s. The sonoluminescent pulses from the heating of the heterogeneities formed by the laser upon adiabatic collapse. References 17: 13 Russian, 4 Western.

USSR

NEW FAST-RELAXING PASSIVE SHUTTER FOR NEODYMIUM GLASS LASERS

Moscow PIS'MA V ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian
Vol 25 No 8, 20 Apr 77 pp 366-369 manuscript received 6 Mar 77

BABENKO, V. A., KUDINOVA, M. A., MALYSHEV, V. I., PROKHOROV, A. M., SYCHEV, A. A., TOLMACHEV, A. I., and SHCHELEV, M. YA., Physics Institute imeni P. N. Lebedev, Academy of Sciences USSR and Institute of Organic Chemistry, Academy of Sciences Ukrainian SSR

[Abstract] The authors discuss the design of a passive shutter with a short relaxation time of the illuminated state equal to 1.5 ns. The authors cite the results of investigations on the emission characteristics of laser radiation with the new passive shutter. They also find that the use of this new past-relaxing passive shutter permits them to produce stable short light pulses with a duration of 2 ± 1 ns at the beginning of a giant pulse train in a laser neodymium glass. Figures 3; references 3: 2 Russian, 1 Western.

USSR

UDC 533.0.004.14:537.311.33

PECULIARITIES OF THE PRODUCTION OF FILMS OF A COMPLEX COMPOUND BY GIANT LASER PULSES

Kiev UKRAINSKIY FIZICHESKIY ZHURNAL in Russian Vol 22 No 4, Apr 77 pp 659-663
manuscript received 24 Mar 76, after final revision 29 Jun 76

OPACHKO, I. I., LUKSHA, O. V., ZAPESOCHNYY, I. P., POP, S. S., and FIRTSAK, YU. YU., Uzhgorod State University

[Russian abstract provided by the source]

[Text] Mass spectrometer measurements are used to estimate the parameters of precipitation of vapor formed when the ferroelectric semiconductor SbSI is vaporized by a giant pulse of neodymium laser emission. It is shown that this technique can be used to produce stoichiometric films of a complex compound under extreme conditions of ultrafast incidence of excited and ionized molecules and atoms of the compound on the substrate, and this introduces peculiarities into the process of film formation. It is also shown that it is possible to control the molecular composition of the vapor and its degree of ionization within certain limits. Figures 2; references 10: 8 Russian, 2 Western.

USSR

INVESTIGATION OF THE TIME BEHAVIOR OF THE X-RAY SPECTRUM OF AN ALUMINUM LASER PLASMA

Moscow PIS'MA V ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian
Vol 25 No 8, 20 Apr 77 pp 373-376 manuscript received 9 Mar 77

KAS'YANOV, YU. S., MAZING, M. A., CHEVOKIN, V. K., and SHEVEL'KO, A. P.,
Physics Institute imeni P. N. Lebedev, Academy of Sciences USSR

[Abstract] The authors investigate the time behavior of the spectral lines of hydrogen-like and helium-like aluminum ions in the x-ray spectrum of laser plasma radiation. With respect to line intensity in the spectrum they determine the temperature and density of the electrons with a time resolution of no more than 1.8 ns. Their investigation revealed that the laboratory x-ray sources open new possibilities for studying the spectra of multicharged ions. These spectra contain considerable information on the elementary processes taking place in the plasma. The authors plot the results of the electron temperature and density measurements at various moments of time. Figures 3; references 8: 6 Russian, 2 Western.

USSR

UDC 621.378.35

INFLUENCE OF HETEROGENEOUS DISTRIBUTION OF IMPURITIES ON THE THRESHOLD CHARACTERISTICS OF AN INJECTION LASER

Minsk IZVESTIYA AKADEMII NAUK BSSR, SERIYA FIZIKO-MATEMATICHESKIKH NAUK in Russian No 2, 1977 pp 84-91 manuscript received 30 Jun 75

KONENKO, V. K., and POLYAKOV, M. YE., Institute of Physics, Academy of Sciences BSSR

[Abstract] A detailed analysis is presented of the variation in the emission threshold of an injection laser with temperature and loss factor in models with constant and variable acceptor gradients, and the influence of the non-linear distribution of impurities on laser characteristics is studied. It is shown that increasing the gradient and concentration of acceptors in the active region of a GaAs laser reduces the emission threshold at high temperatures. The results can be used, in particular, for analysis of processes related to the degradation of laser diodes. The change in the distribution of impurities near the p-n junction affects the value of E_0 and therefore the luminescent and threshold characteristic of the laser. References 16: 9 Russian, 7 Western.

USSR

UDC 533.95:621.384.6

INFLUENCE OF PLASMA OSCILLATIONS ON THE TRANSVERSE PHASE VOLUME OF AN ION BEAM

Leningrad ZHURNAL TEKHNIЧЕСКОY FIZIKI in Russian Vol 47 No 5, May 77 pp
960-965 manuscript received 12 Dec 75

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[Abstract] An important characteristic of an ion beam is its two-dimensional transverse phase volume (reduced emittance)

$$V_{\phi} \approx \frac{1}{\pi} \int_0^{r_0} \Delta v_{\perp}(r) dr,$$

where r_0 is the radius of the beam, Δv_{\perp} is the spread of the radial velocities of the beam at the given point. In this paper it is experimentally shown that stimulation of longitudinal electron oscillations of a plasma and ion oscillations that are nearly transverse with respect to the beam increases V_{ϕ} for a fast ion beam. The experiments were done with helium and hydrogen ion beams with current of 5-20 mA and energy of 25-30 keV, and the plasma formed as a result of ionization of the gas by the beam itself. The maximum values of reduced emittance found with spontaneous stimulation of such oscillations ($V_{\phi} \approx (8-10) \cdot 10^{-5}$ cm·rad when the initial value of the reduced emittance is $V_{\phi} \approx (2-3) \cdot 10^{-5}$ cm·rad) agree with numerical estimates based on the assumption of monochromatic vibrations. Experiments in which an external modulator was used to excite either electron or ion oscillations enabled comparison of the degrees of influence of these types of oscillations on V_{ϕ} for different beam and plasma parameters. The role of both types of oscillations was the same under the conditions of the experiment. With an increase in energy the role of electron oscillations should increase, and ion oscillations should play a greater part at low energies. Figures 7; references 11: 10 Russian, 1 Rumanian.

ON THE POSSIBILITY OF EXISTENCE OF A RADIATION BELT OF THE EARTH MADE UP OF ELECTRONS WITH ENERGIES OF 100 MeV AND HIGHER

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 234 No 4, 1 Jun 77 pp 810-813 manuscript received 28 Dec 76

GRIGOROV, N. L., Scientific Research Institute of Nuclear Physics, Moscow State University imeni M. V. Lomonosov

[Abstract] At least two conditions must be met for a high-energy radiation belt to exist in the vicinity of the earth: 1) high-energy particles must be injected on trajectories that satisfy the conditions of particle capture by the geomagnetic field; 2) the "lifetime" of the particles on these trajectories must be much longer than the time of motion of the particles between points of reflection (mirror points). The author considers a mechanism of the phenomenon that is different from those usually borne in mind when one speaks of radiation belts of the earth. This mechanism may be important for high-energy electrons capture by the geomagnetic field. At an altitude of about 10^3 km above sea level the residual atmosphere is very thin but has a finite density. Cosmic rays interacting with this atmosphere produce pions and kaons that decay to form high-energy electrons. If the pitch angles for these electrons are such that the reflection points of their trajectories lie at high altitudes, then their lifetime will be very great since it is determined only by their interaction with the residual atmosphere, i.e., the lifetime should be proportional to the reciprocal of atmospheric density. Since the intensity of electron flux is proportional to the number of electrons produced in 1 s per unit of volume, which is proportional in turn to density and lifetime, the flux of high-energy electrons captured by the geomagnetic field should be independent of density, i.e., it should be of the same order of magnitude at different altitudes. To determine the order of magnitude of the expected intensity and the form the energy spectrum of the captured particles, the author calculates the electron flux at the equator (geomagnetic latitude zero). Electrons with pitch angle of 75° or more are considered. The results show that the flux intensity of electrons with energy of 100 MeV or more may be close to that of the primary cosmic rays. The captured electrons should be situated in a comparatively narrow range of latitudes and altitudes. In addition to the captured electrons, there should be quasi-captured and albedo fluxes of high-energy electrons as well. These conclusions are not contradicted by the few experimental data available. Figure 1; references 9: 7 Russian, 2 Western.

USSR

UDC 537.5.533

PARAMETRIC EFFECTS WHEN AN ELECTRON BEAM INTERACTS WITH PLASMA

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 234 No 4, 1 Jun 77 pp 806-809
manuscript received 20 Jan 77

AL'TERKOP, B. A., VOLOKITIN, A. S., and TARAKANOV, V. P., Institute of High Temperatures, Academy of Sciences USSR, Moscow

[Abstract] Experiments on the interaction between an electron beam and plasma have shown periodic disruptions of beam instability accompanied by strong modulation of plasma density. It is shown that the cause of this effect may be modulation instability of Langmuir waves that are induced in the plasma by the beam. A system of equations of the nonlinear dynamics of the Langmuir field in a nonisothermal plasma in the one-dimensional approximation is numerically solved in a difference scheme with periodic boundary conditions. Given as initial conditions were perturbations of the field with gaussian distribution and random phases, assuming zero perturbation of the plasma density. The modulation instability of the beam-induced Langmuir waves leads to solitons that flare up and disappear with irregular spatial distribution, and to strong density modulation that is unrelated to field distribution. This state is characterized by strong absorption of plasmons, which may lead to disruption of beam instability. The transmittance of the beam for the plasma is repeated periodically with a characteristic time determined by dissipation of acoustic perturbations. The theoretical conclusions agree with experiments that show disruptions of beam instability accompanied by strong low-frequency modulation of plasma density with recurrence rate of the order of the frequency of electron-ion collisions. Figures 2; references 5: 4 Russian, 1 Western.

USSR

UDC 533.951

THE DISTRIBUTION FUNCTION OF IONIC MICROFIELDS IN A PLASMA

Kiev UKRAINSKIY FIZICHESKIY ZHURNAL in Russian Vol 22 No 6, Jun 77 pp 938-943
manuscript received 13 Oct 76

PARGAMANIK, L. E., and GINZBURG, M. D., Khar'kov State University

[Abstract] This work is dedicated to calculation of the distribution function of ionic microfields in an equilibrium (more precisely, local thermodynamic equilibrium), fully ionized low-temperature Debye plasma. A quantum statistics approach is used with normal ordering of the secondary quantization operators and calculation of their average. By accounting independently for the space and time variance of the plasma permeability one can describe the dynamics of the process of shielding of ion fields in the plasma, i.e., the frequency spectrum of fluctuations of the ion field, which leads to a

distribution function that is appreciably dependent on frequency and is transformed to the known Ecker and Holtmark distribution functions in the limiting cases. A comparison of the results with data of other researchers shows that the contribution to the distribution function is larger with consideration of the spectrum of fluctuations of the field than with consideration of paired correlations. Figures 2; references 17: 12 Russian, 5 Western.

USSR

UDC 538.569

INSTABILITY OF LOW-FREQUENCY PLASMA OSCILLATIONS IN THE FIELD OF A STRONG ELECTROMAGNETIC WAVE

Tbilisi SOOBSHCHENIYA AKADEMII NAUK GRUZINSKOY SSR in Russian Vol 85 No 2, Feb 77 pp 341-344 manuscript received 23 Dec 76

SVIMONISHVILI, I. I., and TSKHAKAYA, D. D., Institute of Physics, Academy of Sciences of the Georgian SSR

[Abstract] The influence of thermal effects on the instability of low-frequency plasma oscillations in the pumping field of a transverse (circularly polarized) strong electromagnetic wave is analyzed, with the relativistic effects of electron motion necessarily taken into account. From the kinetic equation for electrons and ions, with the equations for the vector potential and the scalar potential, a dispersion relation is derived which determines the frequencies of normal modes in the plasma. This equation cannot be solved analytically for the general case and only the low-frequency range is considered here. The solution for this case yields an aperiodic instability, of longitudinal waves only, which is physically explained by a counteraction of the radiation field on the oscillatory motion of particles in a nonhomogeneous plasma. References 5: 4 Russian, 1 Western.

USSR

TOTAL RESONANCE ABSORPTION OF ELECTROMAGNETIC RADIATION IN A HETEROGENEOUS PLASMA

Moscow PIS'MA V ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian
Vol 25 No 8, 20 Apr 77 pp 351-354 manuscript received 24 Feb 77

ALIYEV, YU. M., GRADOV, O. M., KIRIY, A. YU., Physics Institute imeni P. N. Lebedev, Academy of Sciences USSR, VUKOVICH, S., and CHADEZH, V., Institute of Physics, Belgrade, Yugoslavia

[Abstract] The authors explain the effect of total absorption of an electromagnetic wave which arises under resonance conditions with luminescing natural vibrations of a heterogeneous plasma. Analysis of the proposed mechanism for coupling of emission energy into a plasma shows that an electromagnetic wave may be totally absorbed in a nonhomogeneous plasma not only in the case of p-polarization, but with s-polarization as well. Calculations show that an analogous effect takes place for any distributions of plasma density with a "well" in the region of opacity where "trapped" transverse or surface luminescent wave modes arise. Under resonance conditions at the frequency of the luminescing waves in the vicinity of the "well" the electrical field of the wave grows exponentially in comparison with the nonresonance case, which may lead to extrusion of the plasma from the "well" and to the formation of nonlinear plasma configurations of caviton type. Figure 1; references 3: 2 Russian, 1 Western.

USSR

ON RESONANT ABSORPTION OF ELECTROMAGNETIC WAVES IN A HETEROGENEOUS PLASMA

Moscow PIS'MA V ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian
Vol 25 No 8, 20 Apr 77 pp 355-357 manuscript received 27 Feb 77

ZHAROV, A. A., KONDRAT'YEV, I. G., and MILLER, M. A., Scientific Research Institute of Radiophysics

[Abstract] The authors are concerned with the effect caused by synchronized excitation of the mode that is quasilocalized in the resonance region. They find that when a heterogeneous isotropic plasma is exposed to a plane TM type wave there occurs an absorption of energy whose character is virtually independent of the specific loss mechanism. They employ the method and terminology used in transcritical attenuators. They find that it is easy to obtain the boundary condition for the impedance with passage through the plane $z = z_0$. They study the nonreflecting layers by using the equation of transverse impedance of a single-mode transmission line with arbitrary characteristic impedance. The authors find that plasma layers can be constructed which are ideally matched with the plane TM type waves incident on them. References 7: 6 Russian, 1 Western.

USSR

UDC 533.9:542.43

ELECTRIC ARC HIGH-POWER LOW-TEMPERATURE PLASMA GENERATORS

Moscow TEPILOFIZIKA VYSOKIKH TEMPERATUR in Russian Vol 15 No 2, Mar/Apr 77 pp 377-384 manuscript received 12 Jan 76

KOROTEYEV, A. S., LOMOVITSEV, M. A., and BOYARSHINOV, V. V., Moscow

[Abstract] The basic principles of creating long-operating high-power plasmotrons are discussed. The diagrams of coaxial plasmotrons operating on direct current are given. The parameters of the plasmotrons and several of their characteristics are given. Operation of the PK-369 and PK-403 plasmotrons at pressures up to 120 bars and the PK-415 at a pressure of approximately 35 bars is recommended. A combination type plasmotron is recommended when a high-temperature flux generator is required for installations and technological processes. Figures 5; tables 3; references 3 (Russian).

USSR

UDC 533.951

ON TRANSFORMATION OF AN ELECTROMAGNETIC WAVE TO NONLINEAR PLASMA WAVES IN THE HYBRID RESONANCE REGION

Kiev UKRAINSKIY FIZICHESKIY ZHURNAL in Russian Vol 22 No 5, May 77 pp 705-712 manuscript received 27 Apr 76 after final revision 12 Aug 76

DEMCHENKO, V. V., and LEBEDEV, P. M., Physico-Technical Institute, Academy of Sciences UkrSSR, Khar'kov

[Abstract] An examination is made of the change in amplitude of an electromagnetic wave incident on a layer of nonhomogeneous plasma in the region where the wave frequency is close to the plasma frequency. It is shown that integral consideration of the rf potential, spatial dispersion of the plasma and binary collisions of particles in the region of hybrid resonance of a nonhomogeneous magnetically active plasma leads to two peculiarities: 1) when nonlinear effects are considered, the amplitude of the "distending" component of the electric field in the resonance region is appreciably less than that predicted by linear theory; 2) the function $E(x)$ is single-valued for any values of the amplitude of the incident wave and the spatial coordinate. This contradicts previous conclusions on the multiple-valued dependence of field amplitude on coordinate in the resonance region. The authors thank K. N. Stepanov for discussing the results. Figures 3; references 29: 22 Russian, 7 Western.

USSR

UDC 533.916

ACCELERATION OF CHARGED PARTICLES IN A PLASMA OF FINITE TEMPERATURE

Kiev UKRAINSKIY FIZICHESKIY ZHURNAL in Russian Vol 22 No 4, Apr 77 pp 585-590 manuscript received 9 Aug 76

KRASOVITSKIY, V. B., and KRYMSKIY, A. M., Rostov State University

[Russian abstract provided by the source]

[Text] The authors investigate the critical pressure gradient mechanism of acceleration of charged particles in a plasma of finite temperature. It is shown that the space charge that arises in the accelerated flux stabilizes acceleration, and that a steady state is established in the plasma that is maintained by the external source. The "coldest" plasma components are particularly effectively accelerated, which may lead to loss of ions when a plasma is heated to high temperatures. References 4 (Russian).

USSR

UDC 533.9.082

DETERMINING THE SPATIAL DISTRIBUTION OF PULSATIONS OF PLASMA DENSITY FROM THE MODULATION OF A REFLECTED WAVE

Kiev UKRAINSKIY FIZICHESKIY ZHURNAL in Russian Vol 22 No 5, May 77 pp 808-811 manuscript received 11 Aug 76 after final revision 1 Nov 76

SKIBENKO, A. I., and FOMIN, I. P., Physico-Technical Institute, Academy of Sciences UkrSSR, Khar'kov

[Russian abstract provided by the source]

[Text] A technique is described for determining the level of pulsations in a localized plasma layer from the reflection of an electromagnetic wave from the end of a waveguide emitter placed in the plasma. The paper gives the results of measurements in a reflective discharge plasma. The measurements were made by microwave probing on a wavelength $\lambda = 8$ mm, where the maximum plasma density is less than the critical value for the probing frequency. The measured relations are compared with measurements by a twin electric probe. Figures 3; references 9: 8 Russian, 1 Western.

USSR

INFLUENCE OF TEMPERATURE ON KINETICS AND QUANTUM YIELD OF EXTRINSIC LUMINESCENCE

Leningrad FIZIKA TVERDOGO TELA in Russian Vol 19 No 7, Jul 77 pp 2117-2121
 manuscript received 6 Sep 76 after correction 3 Mar 77

TROFIMOV, A. S., and KHOMENKO, YU. M., Ukrainian SSR Academy of Sciences Institute of Theoretical Physics, Kiev

[Abstract] This paper applies a technique developed in an earlier paper to a discussion of the influence of temperature and the quantum properties of the environment on the parameters of energy transfer in processes of non-radiative energy transfer of electron excitation between impurity molecules, in the process of luminescence, in particular. A study is made of the temperature dependence of the effectiveness of resonance-type energy transfer between molecules by using very simple models of donor-acceptor pairs. Transition from the ground state (0), corresponding to unexcited molecules, into state 1 is characterized by a specific dipole moment of transition considerably greater than the magnitude of the dipole moment for transition into state 2, so that the acceptor molecule practically does not interact with light at the transition frequency. Energy level 3, corresponding to the excited state of the acceptor molecule, is thought of as being dipole-active with regard to transition into state 4, the low-energy quasistationary state of the system. Transition directly from state 3 to the ground state is possible in specific instances. Interaction of the donor-acceptor pair with a thermostat (the environment) causes non-radiative transitions between levels 2 and 3, with a specific probability of transition per unit of time when the temperature of the thermostat is zero. The technique developed earlier is applied to derive a system of equations, starting with a set of single-particle wave functions corresponding to these states. These equations incorporate "nu," the mean occupation number of excitations in the thermostat at a specific temperature. The magnitude of nu, in addition to the temperature, is determined by the statistics for excitations in the thermostat, which are either Bose statistics or Fermi statistics depending on the specific system of transitions between states. Equations are derived for the magnitude of the quantum yield of donor and acceptor luminescence, W_D and W_A , respectively, and for approximation of the quantum yield of acceptor luminescence for both cases of transition. Analysis shows that increasing the difference in resonance frequency reduces the efficiency of the donor-acceptor energy transfer process. Characteristic curves are given for the dependence of W_A on temperature. The change in W_A with temperature is due to two factors: 1) Temperature-related growth of the population of excited states of the thermostat causes a relative increase in the probability of transitions of the donor-acceptor system into the state with high transition energy (from state 3 to 2 in one instance, and from 2 to 3 in the other), resulting in a reduction in W_A in one instance, and to an increase in it in the other. 2) The temperature-related change in the effective relaxation parameter, responsible for the temperature-related difference in resonance frequency of states 1 and 2, has a considerable influence on the efficiency of transfer

of excitation from the donor to the acceptor molecule. A law is derived for breakdown in excitation of donor molecules in terms of time. At the zero end of the temperature scale this law does not depend on the statistics for excitations of the thermostat; at the infinity end it does so considerably. Formulas for this law are given for both a Fermi and Bose thermostat. Figures 3; references 4: 3 Russian, 1 Western.

USSR

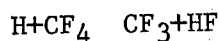
UDC 542.5+62.622+539.18

MEASUREMENT OF THE CONCENTRATION OF HYDROGEN ATOMS IN A HYDROGEN-OXYGEN FLAME AT ATMOSPHERIC PRESSURE

Novosibirsk FIZIKA GORENIYA I VZRYVA in Russian Vol 13 No 3, May/Jun 77 pp 476-477 manuscript received 8 Sep 75

KOCHUBEY, V. F., and MOIN, F. B., Borislov Affiliate of Gosniikhlorproyekt [expansion not known]

[Abstract] A comparatively simple chemical method is proposed for measuring the concentration of hydrogen atoms in a rich hydrogen-oxygen flame. The technique is based on measuring the rate at which hydrogen atoms react with methane tetrafluoride. An investigation of the reaction shows that CF_4 is converted by the mechanism



with a rate constant of

$$k_1 = 10^{14.85} \exp(-43700/RT) \text{ cm}^3/(\text{mole} \cdot \text{s}).$$

The rate of disappearance of CF_4 is given by the differential equation

$$d[CF_4]/dt = -k_1 \cdot [H] \cdot [CF_4].$$

Integration and solution with respect to $[H]$ gives

$$[H]_{av} = -\ln(1 - g_{CF_4})/k_1 \cdot t,$$

where $[H]_{av}$ is the average concentration of hydrogen atoms throughout the reaction zone, t is reaction time and g_{CF_4} is the percentage of converted CF_4 .

The conversion of CF_4 is measured from the amount of HF formed, bearing in mind that four molecules of HF are formed for each reacted molecule of CF_4 (or each hydrogen atom), so that

$$g_{CF_4} = M_{HF}/4M_{CF_4}^0,$$

where M_{HF} is the number of moles of HF formed, and $M_{CF_4}^0$ is the number of moles of CF_4 in the initial mixture. Figure 1; references 13: 5 Russian, 8 Western.

USSR

UDC 543.423

INVESTIGATION OF THE DISTRIBUTION OF NITRIC OXIDE AND HYDROXYL IN THE FLAMES OF BALLISTIC POWDERS

Novosibirsk FIZIKA GORENIYA I VZRYVA in Russian Vol 13 No 2, Mar/Apr 77 pp 268-271 manuscript received 29 Oct 75

DAVIDCHUK, YE. L., MAL'TSEV, V. M., MARGOLIN, A. D., PETROV, YU. M., and RYABIKOV, O. B., Institute of Chemical Physics, Academy of Sciences USSR, Moscow

[Abstract] The profiles of nitric oxide and hydroxyl concentrations in flames of ballistic powders A, B and nitrocellulose (12% N) are determined at a pressure of 1-20 atmospheres. The concentration was measured by the method of absorption spectroscopy. The distribution of nitric oxide was calculated with respect to flame height. The concentration of hydroxyl measured at 1 atmosphere in a powder flame was 10^4 times the equilibrium value. The nitric oxide concentration in the incomplete combustion zone decreases with increasing distance from the burning surface. The difference between the measured and calculated concentrations differ in absolute value by a factor of no more than 1.5; behavior with height is qualitatively alike. Figures 3; table 1; references 9: 8 Russian, 1 Western.

USSR

UDC 535.343.1:535.33/34:533.9

RADIATIVE RECOMBINATION OF CHLORINE IN INCIDENT SHOCK WAVES

Kiev UKRAINSKIY FIZICHESKIY ZHURNAL in Russian Vol 22 No 6, Jun 77 pp 909-914 manuscript received 24 Nov 76

BELOKRINITSKIY, N. S., KERNAZHITSKIY, L. A., ROMANENKO, V. I., and SHPAK, M. T., Institute of Physics, Academy of Sciences UkrSSR

[Abstract] This work is dedicated to a study of the radiative recombination of chlorine atoms in the 500-1250 nm spectral range following thermal dissociation of undiluted molecular chlorine under the influence of a shock wave. The light radiation from the equilibrium area behind the leading edge of the incident shock wave was studied as a function of temperature and wave length. The qualitative and quantitative results are interpreted on the basis of curves of the potential energy of the chlorine molecules. The studies were performed in a shock tube of stainless steel with an inside diameter of 81 mm and a length of 9 m. It consists of a high pressure chamber, low pressure chamber and receiver. A calibrated copper diaphragm between the high and low pressure chambers ruptures at a predetermined hydrogen pressure in the high pressure chamber. The low pressure chamber is filled with the chlorine at an initial pressure of 10-100 mm Hg. The shock wave formed when the diaphragm ruptures heats the chlorine to 1400-2300 K producing a degree of dissociation

of 2-50%. Two radiation maxima are found at 650 nm and 800 nm, corresponding to -3.8 ± 1.5 kcal/mol and -4.2 ± 1.5 kcal/mol respectively. References 20: 9 Russian, 11 Western.

USSR

ON THE LOW-HYBRID HEATING OF PLASMA IN TOKAMAKS

Moscow PIS'MA V ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian
Vol 25 No 8, 20 Apr 77 pp 358-360 manuscript received 2 Mar 77

MUSHER, S. L., RUBENCHIK, A. M., and STURMAN, B. I., Institute of Automation
and Telemetry

[Abstract] The authors examine the heating of plasma by an rf field at frequencies near the low-hybrid frequency. They make computations for heating by a fast and a slow wave and obtain the spatial distribution of absorbed strength. Recent experiments have shown that a large part of the UHF power is released at the periphery of the plasma discharge. This is explained mainly by the development of parametric instabilities. They study an isothermal plasma whose density varies across the magnetic field. In their computations they employ the plasma parameters corresponding to the TM-3 tokamak. The small amount of energy released from the B-wave at the periphery and the relatively great length of absorption indicate that the collective heating method could be combined with that based on linear transformation and make the B-wave promising for heating in large tokamaks. Figures 3; references 2 (Russian).

USSR

UDC 533.92:621.039.01

MAGNETIC SURFACES OF A TOROIDAL STELLARATOR WITH PASSAGE OF LONGITUDINAL
CURRENT IN VACUUM

Kiev UKRAINSKIY FIZICHESKIY ZHURNAL in Russian Vol 22 No 3, Mar 77 pp 442-
446 manuscript received 24 Aug 76

ALEKSIN, V. F., SEBKO, V. P., and TYUPA, V. I., Physico-Technical Institute,
Academy of Sciences UkrSSR, Khar'kov

[Russian abstract provided by the source]

[Text] The paper examines the influence that toroidality and longitudinal current with consideration of plasma pressure have on the shape of magnetic surfaces of a triple-helix stellarator.

It is shown that with increasing longitudinal current in the plasma under conditions of identical rotations of the force lines of the longitudinal current and the external helical winding (the case of twisting) or with an increase in gas-kinetic pressure, the paraxial separating surfaces disappear. Expressions are found for the conditions of disappearance of resonance rosettes inside the stellarator configuration in the presence of a current-carrying plasma with consideration of plasma pressure.

Under conditions of untwisting, with increasing longitudinal current and

gas-kinetic pressure the effects of toroidality lead to a considerable alteration of magnetic surfaces, which may be responsible for the anomalously fast plasma drift in a triple-helix stellarator that has been observed in a number of experiments. Figures 3; references 9: 7 Russian, 2 Western.

USSR

UDC 535.81

SYNTHESIS OF ANASTIGMATIC CONDENSERS WITH SPHERICAL MIRRORS

Moscow OPTIKA I SPEKTROSKOPIYA in Russian Vol 43 No 2, Aug 77 pp 354-358
manuscript received 7 Apr 76

BOSHNYAK, B. M., and KOROLEV, A. N.

[Abstract] The presence of spherical mirrors laid out conventionally for small incidence angles compounds the astigmatism so that, after many reflections, it becomes excessive. A method of compensating these significant aberrations in a condenser system is based on an unconventional layout for large incidence angles. Accordingly, the analytical theory of aberration in systems with eccentric surfaces is applied here to the synthesis of two-mirror condensers. The fundamental equations of geometrical optics are solved and the critical aberration is calculated as a function of the magnifications and the aperture angles. In a practical design the aberration can be reduced to values of $4.7 \cdot 10^{-3}$ meridionally and $-9.4 \cdot 10^{-3}$ sagittally. The real intermediate image produced in such a system can be useful for modulating the light or for analytical purposes. Figures 3; references 5: 4 Russian, 1 Western.

USSR

UDC 535.417.06

APPLICATION OF THE HOLOGRAPHIC METHOD TO STELLAR INTERFEROMETRY

Moscow OPTIKA I SPEKTROSKOPIYA in Russian Vol 43 No 2, Aug 77 pp 324-330 manuscript received 30 Sep 76 after revision 3 Feb 77

VAYTSEL', V. I.

[Abstract] The presence of a turbulent atmosphere presents a major obstacle to astronomic observations based on conventional interferometry. This difficulty can be overcome by applying the principle of interference between independent fields. The information content of a signal here depends largely on the quality of the interference pattern, which is adequately characterized by the degeneracy parameter, i.e., the mean number of photons appearing in the segments where interference lines of a constant probability density of photon appearance form a regular pattern during its periods of stability. The area of these segments is of the order of the coherence area of the measured radiation and the period of stability is equal to the coherence time. A degeneracy parameter is now introduced on the basis of the space-time changes in the interference pattern due to distorting objects or other factors such as atmospheric turbulence. The holographic method is used with a stellar interferometer which also photoelectrically records the interference pattern of the original fields and their Fourier transforms, after the accuracy of its measurement of the mutual-coherence function has been analyzed. Figures 2; references 10: 6 Russian, 4 Western.

USSR

UDC 621.373:535

CONCURRENCE OF OPPOSING WAVES IN A SINGLE-ISOTOPE RING LASER WITH AN ANISOTROPIC RESONATOR

Moscow OPTIKA I SPEKTROSKOPIYA in Russian Vol 43 No 2, Aug 77 pp 320-323 manuscript received 27 Apr 76

BIRMAN, A. YA., SAVUSHKIN, A. F., and TROPKIN, YE. N.

[Abstract] Concurrence of opposing waves in a ring laser with a single-isotope active medium can lead to instability of the two-wave emission mode and produce regions near the center of the atomic transition line where only one wave is generated. On the basis of the dispersion characteristics of a ring laser with arbitrarily polarized opposing waves, with a few appropriate simplifications, the stability ranges of single-wave emission are analyzed here for a ring laser with elliptic polarization of the opposing waves. References 8: 6 Russian, 2 Western.

USSR

UDC 621.373:535

MODES OF A RING CAVITY WITH AN ADDITIONAL REVERSING MIRROR

Moscow OPTIKA I SPEKTROSKOPIYA in Russian Vol 43 No 2, Aug 77 pp 311-319 manuscript received 20 Oct 75 after revision 7 May 76

MILOVSKIY, N. D., and POPOVA, L. L.

[Abstract] The general theory of ring cavities is extended to the case where appreciable backscattering occurs. Such a resonator is replaced with equivalent two coupled resonators and the characteristic equation at the laser self-excitation threshold is derived. Two infinite sequences of natural modes are found to exist, with two modes of the same order but in other sequences differing either in the magnitude of the attenuation factor (when they are degenerate with respect to frequency) or in the natural frequency (when their attenuation factors are equal). The natural frequencies and the Q-factors of all modes depend largely on the location of the backscattering object inside the resonator cavity as well as on the magnitude of the scattering coefficient, being in several cases very sensitive to changes in these parameters. The traveling wave ratio will be maximum under certain conditions and, in the extreme case, a "pure" traveling wave can be obtained. Figures 4; references 15: 11 Russian, 4 Western.

USSR

UDC 535.324+535.341]:539.238

OPTICAL PROPERTIES OF Si_3N_4 FILMS

Leningrad OPTIKA I SPEKTRISKOPIYA in Russian Vol 43 No 2, Aug 77 pp 244-248
manuscript received 20 Aug 75 after revision 20 Jun 76

SHITOVA, E. V., YASNEVA, I. A., and GENKINA, N. A.

[Abstract] Developments in controlled thin-film technology have made dielectric films such as silicon nitride applicable not only in translucent optics but also as a replacement for metallic films on mirrors. A study was made concerning the frequency dispersion of the refractive index and of the absorption coefficient of Si_3N_4 films deposited on silane and ammonia ($\text{SiH}_4:\text{NH}_3 = 1:4$) in high-frequency plasma at 400°C , as well as of the effect of technological factors on the refractive index and the optical density of such films. Experimental data obtained over the $0.7\text{--}1.5\ \mu\text{m}$ range of wavelengths and RCA data for the $0.25\text{--}0.6\ \mu\text{m}$ range are compared here with theoretical data and, on this basis, a dispersion equation is derived for the entire optical range. Increasing the power of high-frequency plasma discharge is found to increase, rather than decrease, the optical density of these films. Increasing the infrared power results in the appearance of a new absorption band, as yet not identified but near the $4.0\ \mu\text{m}$ wavelength, probably due to the presence of some impurities. Figures 6; references 5: 3 Russian, 2 Western.

USSR

UDC 621.372.8

STUDY OF OPTICAL LOSSES IN GLASS FIBER LIGHT GUIDES

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 4 No 4, Apr 77 pp 937-941 manuscript received 17 Nov 76

BELOV, A. V., GUR'YANOV, A. N., DIANOV, YE. M., LUZHAIN, V. G., NEUSTROYEV, V. B., NIKITIN, YE. P., and YUSHIN, A. S., USSR Academy of Sciences Physics Institute imeni P. N. Lebedev, Moscow, and USSR Academy of Sciences Institute of Chemistry, Gor'kiy

[Abstract] Total optical losses in a glass fiber light guide (SVS) are determined by two key factors: The degree of purity of the raw material, and the homogeneity of the physical and geometrical parameters of the SVS. The first factor determines the amount of loss resulting from absorption, and the second, resulting from emission. This paper presents the results of a study of spectral distributions of total losses versus wavelength and of losses resulting from emission versus wavelength in several lots of SVS's with low losses of about $10\ \text{dB/km}$ and with abrupt change in refractive index at the core-coating interface, amounting to about 0.01 . Measurements are made of absorption losses in the raw material for several specimens of SVS's to find

out whether additional absorption losses take place in the process of drawing the SVS's. To explain the influence of the inhomogeneity of the SVS parameters, a study is made of the distribution of radiation intensity over side surface $r(z)$ along the entire length of the SVS. The loss spectra mentioned above were studied in the 0.45 to 1.1 micron range. The SVS's studied had a core of pure quartz glass and a borosilicate coating and were made by the method of chemical deposition from the gas phase. The diameter of the core varied from 35 to 50 microns, the thickness of the coating from 10 to 15 microns, and the total diameter of the SVS from 140 to 180 microns. A description is given of the measurement method and setup used. Specimens of SVS's from different lots had identical spectral distributions of losses with rare exceptions. Minimal total losses in the 0.7 to 0.9 micron region were 7-12 dB/km, and as much as 20 to 30 dB/km in the 0.63 to 0.95 micron region. Absorption losses in the raw material were measured by a calorimetric method. Additional absorption losses were not detected after drawing the SVS's in the majority of instances. The results of the study made here demonstrate that the technology used makes it possible to manufacture with good reproducibility process stock (raw material) and SVS's with a low impurity content and with good homogeneity of the core material. Total losses in the 0.8 to 0.9 micron region of the spectrum, which is promising for use in optical communications lines, amounted to less than 10 dB/km, and the main contribution to total losses was made by losses resulting from emission, amounting to 5 to 7 dB/km and due to imperfect geometry of the SVS's. Total losses within this region of the spectrum could be reduced to 3 to 4 dB/km if this technological flaw were eliminated. Figures 5; references 9: 3 Russian, 6 Western.

USSR

UDC 621.378.34

STUDY OF THE PARAMETERS OF A FIBER-OPTICAL QUANTUM IMAGE AMPLIFIER

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 4 No 4, Apr 77 pp 887-889 manuscript received 17 Jun 76

KOVAL'CHUK, V. L., KONAREV, V. P., LOMAKIN, V. N., and MATVEYEV, I. N.

[Abstract] This paper is devoted to an experimental evaluation of the quality of the image at the output of a pulsed fiber-optical quantum image amplifier (OKU) with an operating wavelength of 1.06 microns, a power gain factor of 38 dB, and a pumping pulse repetition frequency of 20 Hz maximum. The quality of the image is evaluated by means of easily measured parameters such as the amplitude characteristic, the signal-to-noise ratio, and the light curve, which define definition, graininess, and tone, respectively. Both the fiber bundle and the pumping tube were water-cooled, which made it possible to reach a frequency of 20 Hz. The fibers of the bundle were laid in a single layer along the entire length of the tube on a glass mounting to achieve even pumping. The fibers were made of glass activated with neodymium, with an overall cross section of 2 X 2 mm. The material of the core was GLS2 glass. The amplitude characteristic was measured by feeding a signal from a Q-switched YAG laser with spatial modulation by an optical focusing pattern, to the fiber OKU's

input and then, by means of a slotted photomultiplier, recording the flux distribution in the outgoing image plane of the OKU. This operation was repeated for a number of optical focusing patterns with different densities. The experiment demonstrated that the maximum resolution of actual active fiber bundles is no greater than 10 lines/mm. A photograph is shown of the optical focusing pattern at the OKU's output. A curve is shown, expressing the dependence of the signal-to-noise ratio on the flux intensity at the OKU's input. A formula is given for determining the dependence of the signal-to-noise ratio on the strength of the input signal. The slope of the light curve increases drastically when the OKU is pumped. It is concluded that fiber-optical quantum image amplifiers make it possible to increase substantially the absolute value of image contrast, as compared with the passive method. The resolution of a fiber bundle under active conditions is not inferior to that under passive conditions and can be brought up to the level of values achieved presently for passive fiber conductors. Figures 5; references 5: 4 Russian, 1 Western.

USSR

UDC 535.215

OPTICAL RECORDING OF INFORMATION USING CADMIUM SULFIDE

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 4 No 4, Apr 77 pp 857-861 manuscript received 28 Jun 76

KYNEV, S. K., KOPARANOVA, N. S., GEORGIYEV, M., TSVETKOVA, K. B., TODOROV, T. A., and SYNOV, V. KH., Institute of Solid State Physics and Central Laboratory for Optical Recording and Information Processing of the Bulgarian Academy of Sciences, Sofia, People's Republic of Bulgaria

[Abstract] A reduction in photosensitivity in the process of exposure has been observed in photoelectric devices based on cadmium sulfide, particularly when doped with cadmium and copper. The rate of degradation increases with an increase in the copper concentration, temperature, and strength of exposure. Degradation of the photocurrent is caused by photoelectronic and photochemical processes taking place in the material under the effect of exposure. Consideration has recently been given to methods of utilizing this phenomenon. One possible application is formation of a latent "photoelectric image." By this method it is possible to record photoimages and convert them into a sequence of electrical signals. A thin sprayed film of CdS is used for recording. One section of it is pre-exposed; the other half, adjacent to it, is not. A thin light beam scans the film and reproduces the recorded image. Owing to degradation the photocurrent in the exposed section is weaker, the greater the illumination during exposure. At the exposure interface the photocurrent jumps two to three orders of magnitude. The image can be erased by heating, and a new recording can be made. This paper examines the possibilities of using cadmium sulfide as a medium for optical recording of information. A description is given of experiments done to study these possibilities. Comparison between the sensitometric parameters of CdS:Cd:Cu films and those of commercial

photographic materials shows that photoelectric recording using CdS results in low "photographic sensitivity," but high "contrast" and "photographic latitude." Recording sensitivity, defined as the minimal light power causing reliably registerable (well reproduced) degradation of photocurrent, is 5×10^{-6} J/cm², indicating high sensitivity of photocurrent degradation to the optical information scanning process. Response of the photocurrent to the activating optical signal is better than 10^{-3} s. These features make it feasible to create a system for bit-by-bit recording of information using a CdS crystal, in which the information recorded optically is directly converted into an electrical signal when it is read. Studies were also made to compare the material's change in photoelectric properties associated with degradation of photocurrent and a change in optical properties. Relatively high changes in optical density were observed; this led to an experiment in recording a three-dimensional hologram using a simple interferometer setup. Diffraction efficiency (ratio of the strength of the diffracted beam to that of the incident beam) when using CdS:Cd:Cu was greater than one percent with spatial density of 2000 lines/mm and recording power of about 1 J/cm². Required recording time was 10 s, and data could be stored in darkness at least 100 h. Optical erasing was possible 10 times, and thermal without limitation. Crystals of CdS:Cd:Cu are considered promising as recording materials with interesting possibilities. Figures 6; tables 1; references 17: 11 Russian, 6 Western.

USSR

UDC 535.34:666.01

SUPPLEMENTARY INFRARED ABSORPTION IN LEAD-BORATE GLASSES

Minsk ZHURNAL PRIKLADNOY SPEKTROSKOPII in Russian Vol 26 No 6, Jun 77 pp 1126-1127 manuscript received 19 May 76

KOZLOV, I. N., KURTSINOVSKAYA, R. I., and YUDIN, V. M.

[Abstract] Lead-borate glasses with composition $x\% \text{ PbO} \cdot (100-x)\% \text{ B}_2\text{O}_3$ were exposed at room temperature in air to a dose of the order of 10^8 r on a Co^{60} gamma source. Possible shifts of infrared absorption induced by the irradiation were studied. An additional band shows up in the irradiated specimens at about 800 cm^{-1} . This is attributed to intensification of the interaction of the glass surface with oxygen in the radiation field, leading to absorption of the oxygen by the glass and hence the supplementary infrared absorption in the spectrum. Figure 1; references 3: 2 Russian, 1 Western.

USSR

UDC 621.378.325

A HIGH EFFICIENCY PICOSECOND PARAMETRIC LIGHT EMITTER WITH NARROW EMISSION SPECTRUM AND HIGH PULSE RECURRENCE RATE

Leningrad ZHURNAL TEKHNIЧЕСКОY FIZIKI in Russian Vol 47 No 5, May 77 pp 1075-1077 manuscript received 21 May 76

DANELYUS, R., DIKCHYUS, G., KABELKA, V., and PISKARSKAS, A., Vil'nyus State University imeni V. Kapsukas

[Abstract] The paper gives the results of an investigation of the energy and spectral characteristics of a parametric light emitter based on a two-crystal circuit. Such an emitter on α - HfO_3 crystals has an energy efficiency as high as 12%, frequency width of the emission line of $4\text{--}5\text{ cm}^{-1}$ in the $1\text{ }\mu\text{m}$ region, and pulse recurrence rate of 25 Hz. The energy and frequency characteristics of the proposed emitter meet the requirements of spectroscopic applications. Emission frequency is continuously tunable over a range of $0.3\text{--}3\text{ }\mu\text{m}$. Figures 3; references 9: 5 Russian, 4 Western.

USSR

UDC 537.533.34

INVESTIGATION OF TRANSAXIAL ELECTROSTATIC MIRRORS AT LARGE ANGLES OF INCIDENCE OF A BEAM OF CHARGED PARTICLES

Leningrad ZHURNAL TEKHNIЧЕСКОY FIZIKI in Russian Vol 47 No 5, May 77 pp 917-925 manuscript received 9 Dec 75

BOBYKIN, B. V., KARETSKAYA, S. P., KEL'MAN, V. M., and FEDULINA, L. V., Institute of Nuclear Physics, Academy of Sciences Kazakh SSR, Alma-Ata

[Abstract] In previous research the authors considered the electron-optical properties of transaxial electron mirrors assuming that the incident and reflected beams of charged particles have a common rectilinear axis. In practical use of such a system, either the object or the screen on which the image is projected is located in the path of the beam. Thus a deflecting magnetic field is needed and this distorts the image. This difficulty is eliminated if the beam is incident on the mirror at an appreciable angle to the line passing through the center of the mirror and the pivot point of the axial trajectory of the beam. In actual systems this line acts as the axis of the mirror. In this paper a theory is presented for the focusing action of such transaxial electrostatic mirrors for beams of charged particles with curvilinear axis. This theory includes an analysis of geometric aberrations of second order. Figure 1; references 3 (Russian).

USSR

UDC 537.533.34

CALCULATION OF A TWO-ELECTRODE TRANSAXIAL ELECTROSTATIC MIRROR AT LARGE ANGLES OF INCIDENCE OF THE CHARGED PARTICLES

Leningrad ZHURNAL TEKHNIЧЕСКОY FIZIKI in Russian Vol 47 No 5, May 77 pp 926-933 manuscript received 9 Dec 75

BOBYKIN, B. V., KARETSKAYA, S. P., KEL'MAN, V. M., and FEDULINA, L. V., Institute of Nuclear Physics, Academy of Sciences Kazakh SSR, Alma-Ata

[Abstract] The paper gives the results of a numerical calculation of paraxial electron-optical properties and aberrations of a two-electrode transaxial electrostatic mirror assuming that the axis of the beam incident on the mirror makes a large angle with the axis of the mirror. The calculation is based on formulas given in another article by the authors ["Investigation of Transaxial Electrostatic Mirrors at Large Angles of Incidence of a Beam of Charged Particles," Zhurnal Tekhnicheskoy Fiziki, Vol 47 No 5 May 77 pp 917-925]. Each of the electrodes is a pair of parallel plates, the distance between plates being the same in each pair. The gaps between the plates in both electrodes are arcs of circles with center lying on the z-axis. It is assumed that the dimensions of the electrodes are great enough compared with the distance between them that the field in the region of motion of the charged particles can be considered symmetric relative to the z-axis. It was also assumed that the gap between electrodes is infinitesimally small. Tables are given showing the ratios of the potentials on the electrodes, parameters characterizing the electron-optical properties of the mirrors and aberration coefficients. Figures 4; tables 3; reference 1 (Russian).

USSR

UDC 537.56+546.291

ANGULAR DISTRIBUTIONS OF ELECTRONS EMITTED WHEN HELIUM ATOMS ARE IONIZED BY ELECTRON IMPACT

Leningrad OPTIKA I SPEKTROSKOPIYA in Russian Vol 43 No 1, Jul 77 pp 34-38 manuscript received 17 May 76

MISHCHENKO, T. V., SENASHENKO, V. S., and STRAKHOVA, S. I.

[Abstract] The authors analyze the possibilities of the Born approximation for describing ionization of helium atoms by fast electrons. The calculations are done with a wave function of the continuous spectrum derived in the potential of a frozen He^+ core with consideration of exchange. The angular distributions of the emitted electrons are calculated for incident electron energies of 500-1000 eV. The energy of the emitted particles was 40-200 eV. It was found that with increasing energy of the incident and knock-on electrons ($E = 1000$ and 200 eV) calculations with the wave function of the emitted electrons derived in the frozen core approximation reproduce fine details of

angular distributions experimentally observed in the large angle region that are associated with the appearance of a second maximum which does not show up in calculations with Coulomb wave function of the knock-on electron. It is possible that the angular distributions of the emitted electrons may be influenced by still other more complicated ionization mechanisms. The authors thank V. V. Balashov for assistance with the work and constructive criticism. Figures 2; references 10: 1 Russian, 9 Western.

USSR

UDC 620.179.1:620.191.33.778.38

USING A STROBOHOLOGRAPHIC METHOD FOR DETECTING FATIGUE CRACKS IN THE TURBINE
BLADES OF GAS-TURBINE ENGINES

Leningrad ZHURNAL TEKHNIЧЕСКОY FIZIKI in Russian Vol 47 No 5, May 77 pp 1072-
1073 manuscript received 17 Apr 76

ZARUTSKIY, M. A., PRIKLONSKIY, A. I., TROFIMOVSKIY, V. V., and BAVEL'SKIY, D.
M., Riga Institute of Civil Aviation Engineers imeni the Lenin Komsomol

[Abstract] A stroboscopic method was used to detect fatigue cracks in the refractory material of turbine blades. The method is based on analysis of the interference patterns obtained with strobing of exposure on resonant frequencies. The experimental installation is a conventional two-beam holographic interferometer based on an LG-38 He-Ne laser and an ML-3 modulator. Cracks were identified from anomalies in the interference pattern caused by localized changes in deformation characteristics. The modes of vibration with the highest information content were bending, and bending with twisting. Figure 1; table 1; reference 1.

USSR

UDC 632.451.3+532.5

INVESTIGATION OF THE PROCESS OF COMPRESSION OF THE CASING OF AN ELONGATED
SHAPED CHARGE AND FORMATION OF KNIFE-SHAPED ELEMENTS

Novosibirsk FIZIKA GORENIYA I VZRYVA in Russian Vol 13 No 2, Mar/Apr 77 pp
244-254 manuscript received 8 Dec 75

SHEKHTER, B. I. (deceased), SHUSHKO, L. A., and KRYV'KOV, S. L., Ramenskoye
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[Abstract] A model based on theoretical and experimental research is proposed for an elongated shaped wedge charge, and exact and approximate techniques are proposed for calculating pestle-shaped and knife-shaped elements. It is assumed that the detonation wave is flat and sliding, and the wave front (direct or indirect) has an angle ψ of inclination to the plane of normal flow of the elongated shaped charge that varies from 0 to 90°. The metal of the casing is treated as an ideal or viscous incompressible liquid, and the velocity vectors of the shaped pestle and knife charge lie in the plane normal to the line of collapse of the casing. Satisfactory agreement between experimental and theoretical data shows the validity of the assumed model and computational technique. The results can be used to determine the effectiveness of a shaped knife charge. Table 1; figures 6; references 15: 14 Russian, 1 Western.

USSR

UDC 539.3

DETERMINATION OF CRITICAL PRESSURE FOR SHELLS IN PROCESS OF DEVELOPMENT

Kiev DOPOVIDI AKADEMIYI NAUK UKRAYINS'KOYI RSR SERIYA A. FIZYKO-MATEMATYCHNI
TA TEKHNICHNI NAUKY in Ukrainian No 4, Apr 77 pp 321-323 manuscript received
2 Jul 76

BABENKO, V. I., Physico-Technical Institute of Low Temperatures

[Abstract] The method proposed in Dopovidi AN Ukr SSR, Series A, 1977 No 3
(by the author) is expanded to apply to the case of the main asymptotics of
critical pressure for a convex developing shell supported in hinge fashion
along the boundary. Several systems of equations are developed for this pur-
pose.

USSR

APPLICATION OF A DISPERSION RELATION IN ANALYZING TUNNEL DATA

Leningrad FIZIKA TVERDOGO TELA in Russian Vol 19 No 7, Jul 77 pp 1994-2000
manuscript received 2 Feb 77

SVISTUNOV, V. M., D'YACHENKO, A. I., and CHERNYAK, O. I., Ukrainian SSR
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[Abstract] It is possible to determine the electron-phonon interaction function, $g(\omega)$, from studies of superconductors in tunnel contact with a normal or superconductive injector. Knowledge of this function gives an exhaustive description of the superconductive state. One of the problems in the tunnel experiment used to study the superconductive properties of materials is finding the density of quasiparticle excitation states, $N_T(\omega)$, and the energy gap, $\Delta_0 = \Delta(\omega_0)$. The raw data for determining $N_T(\omega)$ are the volt-ampere characteristics and conduction of the contact in the superconductive and normal states. $N_T(\omega)$ is used in turn to derive $g(\omega)$ and other characteristics of electron-phonon interaction. The procedure for deriving $g(\omega)$ from $N_T(\omega)$ has already been substantiated. The purpose of this paper is to report on a modernization of this method aimed at expanding the possibilities in analyzing results based on superconductivity theory. This modernization is based on using Eliashberg's equations (1960). The basis of the method is the dispersion relation, which makes it possible to find the complex parameter of the superconductor's energy gap, $\Delta(\omega)$, directly from the tunnel density of states, $n_T(U)$. Then the problem of finding $g(\omega)$ boils down to solving a linear integral equation without the Coulomb pseudopotential, μ^* . Use of the dispersion relation requires knowledge of $n_T(U)$ over a wide energy range considerably surpassing the end of the phonon spectrum. It is demonstrated here that it is possible to plot $g(\omega)$ by using the dispersion relation if the experimental $n_T(U)$ has been determined with energies no greater than ω_0 . Values of $n_T(U)$ for currents (U) greater than ω_0 can be precisely determined by solving a system of Eliashberg equations, based on smooth joining of the experimental $n_T(U)$ with the computed. Only one or two solutions of this type is sufficient to come up with a calculated $n_T(U)$ considerably more accurate than the experimental. If the current is much greater than ω_0 and the experimental $n_T(U)$ is known, this procedure makes it possible to describe in detail mechanisms of interaction determined by the tunnel-type nature of the contact and the $\mu^*(\omega)$ curve, by comparison with the calculated $n_T(U)$. Examples are given of applying this method to analyzing tunnel experiments on the influence of small dopants of antimony in lead and on the influence of high pressures on electron-phonon interaction in lead. Application of the method requires the use of a computer of moderate speed. Figures 5; references 12: 7 Russian, 5 Western.

USSR

RESISTIVE DOMAIN IN A LONG SUPERCONDUCTOR OF SMALL TRANSVERSE SIZE AT TEMPERATURES CLOSE TO THE CRITICAL POINT

Leningrad FIZIKA TVERDOGO TELA in Russian Vol 19 No 6, Jun 77 pp 1600-1607
manuscript received 15 Jul 76 after final revision 18 Nov 76

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[Abstract] The problem of critical currents of a long superconductor of small transverse size is analyzed in terms of electron superheating in metals at temperatures $1 - t \ll 1$, where t is the temperature of the specimen in units of the critical temperature T_c . Conditions of the formation and existence of a resistive domain in such a conductor are determined. The author determines the critical length of the resistive domain $L_{R_{min}}(t) \propto \theta(t)$, where

$$\lambda_{\theta}(t) = \left[\frac{1}{2} l_M(T_c) l \right]^{1/2} \frac{k_B T_c}{p_F s} t^{1/2}$$

and $l_M(T_c)$ is the mean free path of electrons in a massive superconductor when $T = T_c$, l is the mean free path of electrons in the specimen, k_B is Boltzmann's constant, s is the velocity of longitudinal sound in the metal, and p_F is the Fermi momentum. It is noted that an estimate can be obtained for the microscopic quantities that enter into $L_{R_{min}}(t)$. Within the framework of the concepts developed, the minimum voltage drop across a given superconductor of minimum transverse size in the resistive state is given by the formula

$$eV_{R_{min}}(t) = \left(\frac{8}{3} \pi^2 \right)^{1/2} k_B T_c (\theta_{c2} - t)^{1/2} t^{1/2},$$

where θ_{c2} is determined from the equation $\theta_{c2} - t = \frac{8}{5} \beta (1 - \theta_{c2})^3$; β is a constant that depends on the microscopic parameters of the metal. The results of the calculations agree well with measurements on whiskers and thin-film superconductors. Figures 3; references 23: 19 Russian, 4 Western.

USSR

UDC 536.46

IGNITION OF CONGLOMERATES OF METAL PARTICLES

Novosibirsk FIZIKA GORENIYA I VZRYVA in Russian Vol 13 No 2, Mar/Apr 77 pp
164-168 manuscript received 11 Jul 75

BONDAREV, V. N., ZOLOTKO, A. N., KLYACHKO, L. A., POLISHCHUK, D. I., SHEVCHUK, V. G., and YAKOVLEVA, T. A., Odessa State University

[Abstract] An approximate general method is proposed for studying processes of ignition of metal conglomerates without resorting to the approximation of the equally accessible surface. The following assumptions are made: the conglomerate takes the shape of a sphere with given radius made up of spherical particles of fixed radius; the porosity of the conglomerate is $\beta = 1 - \rho_c / \rho_m$, where ρ_m is the density of the metal and ρ_c is the density of the conglomerate (unchanging with time); there is no temperature gradient with respect to the volume of the conglomerate; the concentration of oxidant on the surface of the conglomerate is constant and equal to the concentration of the oxidant in the medium, i.e., the process is not limited by external diffusion; vaporization of the formed oxide and radiative heat exchange are disregarded. The ignition temperature is found from simultaneous solution of equations of heat and mass balance and the law of oxidation of a metal particle. The problem is solved by an approximate integral method with introduction of the concept of the effective depth of penetration of oxidant into a layer of porous material. A comparison with experimental data for a conglomerate of boron particles shows that the proposed model reflects the actual behavior of ignition. Figures 3; 3; references 5: 4 Russian, 1 Western.

USSR

UDC 536.46

CATALYSIS AND INHIBITION OF COMBUSTION IN A LAMINAR SYSTEM OF AMMONIUM PERCHLORATE AND POLYMETHYL METHACRYLATE

Novosibirsk FIZIKA GORENIYA I VZRYVA in Russian Vol 13 No 2, Mar/Apr 77 pp
176-185 manuscript received 10 Mar 76

MARTYNYUK, V.F., BAKHMAN, N. N., and LOBANOV, I. N., Institute of Chemical Physics, Academy of Sciences USSR, Moscow

[Abstract] An investigation is made of the principles that govern catalysis in combustion of laminar systems of ammonium perchlorate and polymethyl methacrylate. Possibilities of inhibition of flame propagation by thin films applied on the contact surface of fuel and oxidant are studied. It is found that thin films of polycarbonate, Teflon and Mylar applied to the surface of contact reduces the rate of flame propagation. An estimate is made of the width of the zone to which the action of the catalyst (Fe_2O_3) spreads. The authors are the

first to make simultaneous measurements of the combustion angle in the fuel plate and oxidant layer. It is shown that the component ratio at a distance of 1 mm or less from the "nose" of the flame is about 0.7. Figures 7; tables 5; references 25: 13 Russian, 12 Western.

USSR

UDC 622.58+66.215.1

LIGHT-FLUX IGNITION OF OCTOGEN

Novosibirsk FIZIKA GORENIYA I VZRYVA in Russian Vol 13 No 2, Mar/Apr 77 pp 271-274 manuscript received 22 Jan 76

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[Abstract] The paper gives the results of a study of the physical pattern of ignition of octogen by a luminous flux. An investigation is made of the effect that light flux density, the composition and pressure of the ambient atmosphere have on ignition time, and conditions of transition from ignition to stable burning are determined. Specimens of octogen with and without 1% carbon black were studied, pressed to a density of $1.7 \cdot 10^3 \text{ kg/m}^3$. Ignition was initiated from the end face of the cylindrical specimen. The results show that octogen ignites in the gas phase. The authors thank V. N. Vilyunov for discussion and constructive criticism. Figures 3; table 1; references 7 (Russian).

USSR

UDC 662.612+543.5

INVESTIGATION OF THE STRUCTURE OF A COMBUSTION WAVE IN COMPOSITE MIXTURES BASED ON AMMONIUM PERCHLORATE, POLYMETHYL METHACRYLATE AND A CATALYST USING THE MASS SPECTROMETRIC AND THERMOCOUPLE TECHNIQUES

Novosibirsk FIZIKA GORENIYA I VZRYVA in Russian Vol 13 No 3, May/Jun 77 pp 335-342 manuscript received 23 Aug 76

KOROBENICHEV, O. P., ZENIN, A. A., TERESHCHENKO, A. G., and PUCHKOV, V. M., Institute of Catalysis, Siberian Department, Academy of Sciences USSR, Novosibirsk

[Abstract] Thermocouple and mass-spectrometry methods are used to study the structure of a combustion wave in condensed media. The model mixture was made up of ammonium perchlorate (particle size 4-5 μm), polymethyl methacrylate (particle size 3 μm), and a catalyst (CuO with specific surface of m^2/g),

CuCr_2O_4 with specific surface of $50 \text{ m}^2/\text{g}$). The experiments were done at low pressures (less than atmospheric) where combustion rates are low and combustion zones are wide (smaller than the size of nonhomogeneities of the mixture composition). It is shown that surface temperature increases weakly with pressure and is practically independent of the ratio of components. The addition of the catalyst reduces the surface temperature. Increasing the concentration of APC and raising the pressure makes the reaction in the condensed phase exothermal. At 300 mm Hg the heat release is practically independent of the presence of catalyst. At 760 mm Hg, the addition of catalyst noticeably raises the heat release in the surface layer of condensed phase and reduces the thermal-conduction heat flux from the gas phase to the condensed phase divided by the mass rate of combustion. Table 1; figures 5; references 13: 5 Russian, 7 Western.

USSR

UDC 536.46+662.311.1

EROSION BURNING OF BALLISTIC POWDERS

Novosibirsk FIZIKA GORENIYA I VZRYVA in Russian Vol 13 No 3, May/Jun 77 pp 462-463 manuscript received 22 Apr 76

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[Abstract] An experimental study is done on the influence that the velocity and temperature of a gas flow have on erosion burning of ballistic powders. Two compositions are investigated with maximum combustion temperature of 1600 K, the burning rate of one powder being 1.4 times higher than that of the other. The experiments were done at a pressure of 60 atmospheres. The powder specimens were cylinders 4.5 cm long and 1.0 cm in diameter, and the gas flowing over the burning surface had temperatures of 1600, 2300 and 3400 K. The results are given as graphs of the coefficient of erosion $\xi = u_n/u_0$ as a function of the parameter $I = v\rho\sqrt{\lambda}/u_0\rho_0$, where u_n is the burning rate of the powders in the flow, u_0 is the quiescent burning rate, ρ_0 is powder density, v is the velocity of the gas flow, ρ is gas density and λ is drag. It was found that ξ increases with I , beginning with a certain threshold value of I . As the temperature of the gas flow increases, there is a reduction in the threshold value of I and an increase in the coefficient of erosion. This increase is sharper with higher gas temperature and larger I . The authors thank professor V. N. Vilyunov for constructive criticism and interest in the work. Figure 1; references 8: 7 Russian, 1 Western.

CSO: 1862

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